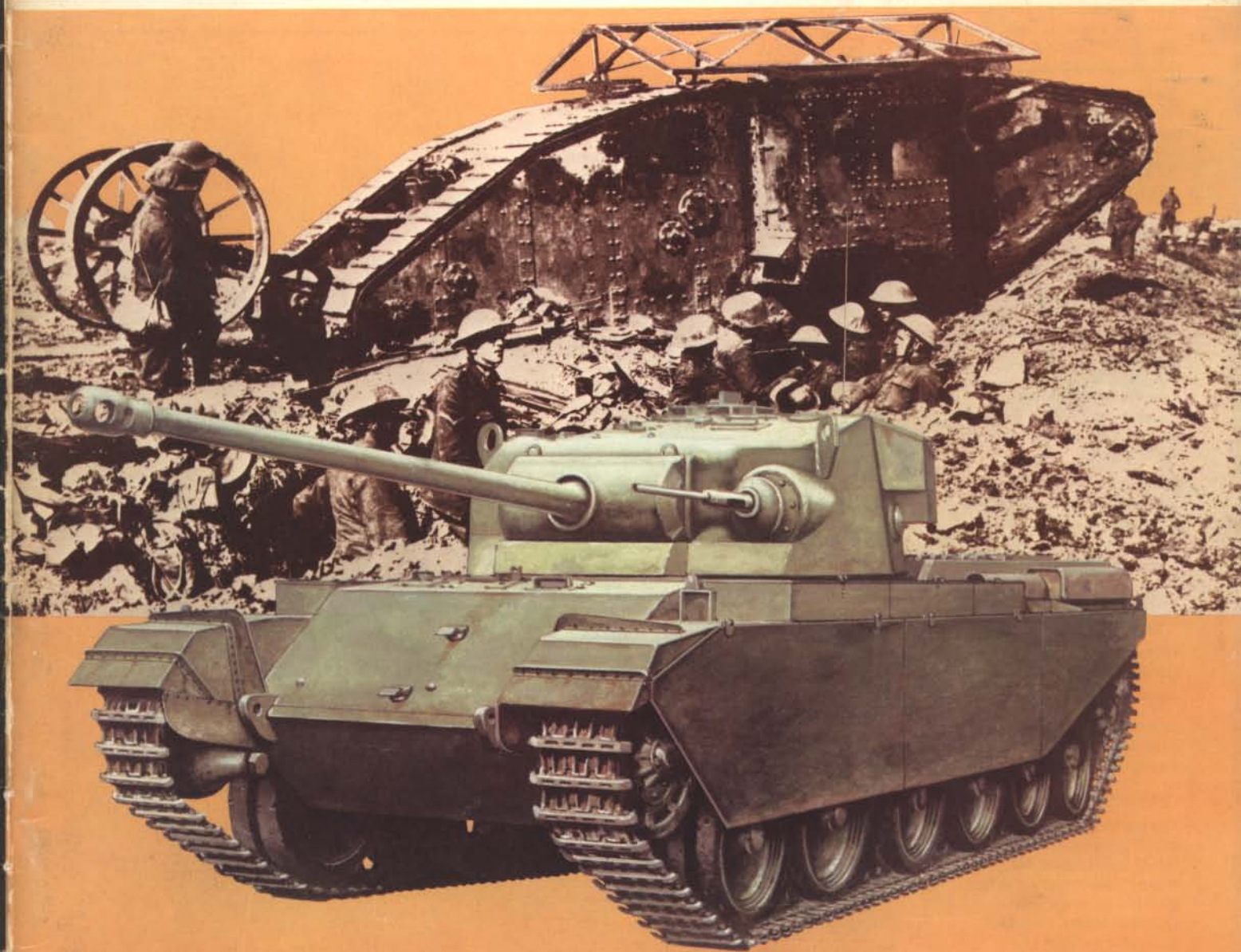
WAR MONTHLY

ISSUE 15

45p $1.50

AUSTRALIA $1.25* CANADA $1.50 N.Z. $1 S.AFRICA R1.25



BRITISH TANKS 1914-45

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Subscription rates
For 12 months:

UK and Eire	£6.10
US and Canada	$18
Other countries (exc. NZ)	£8.50
New Zealand	£7.50

These prices include packing and postage. Orders should be sent with payment to Subscriptions Department, Marshall Cavendish Ltd., 58 Old Compton Street, London W1V 5PA. Be sure to state from which number you wish your subscription to begin. Subscriptions will be sent by surface mail from England.

Back numbers
Back numbers of War Monthly are available from Department V, M/C Ltd., P.O. Box 80, Slough, SL3 8BN, England, for 45p per issue including postage.

Readers in the US and the British Commonwealth outside the UK should obtain back numbers through their regular magazine supplier.

Published by
Marshall Cavendish Ltd.,
58 Old Compton Street,
London, W1V 5PA, England.
Telephone 01-734-6710.
Telex 23880

Printed in Great Britain by
Severn Valley Press Ltd.,
Caerphilly, Glamorgan.

US and Canada on sale date:

June 1975

* Recommended retail price

Picture research undertaken by Carina Dvorak.

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Art Direction: Chris Harrison
Design: Eric North

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Syndication International

The mean-looking 105mm gun of this Israeli Centurion during exercises in the Negev Desert was soon to go into action against Egyptian armor. This AFV just missed action in 1945, six prototypes arriving as hostilities came to an end. No fewer than 13 marks of Centurion were developed, plus a number of variants including tank-recovery.

BRITISH TANKS 1914-45

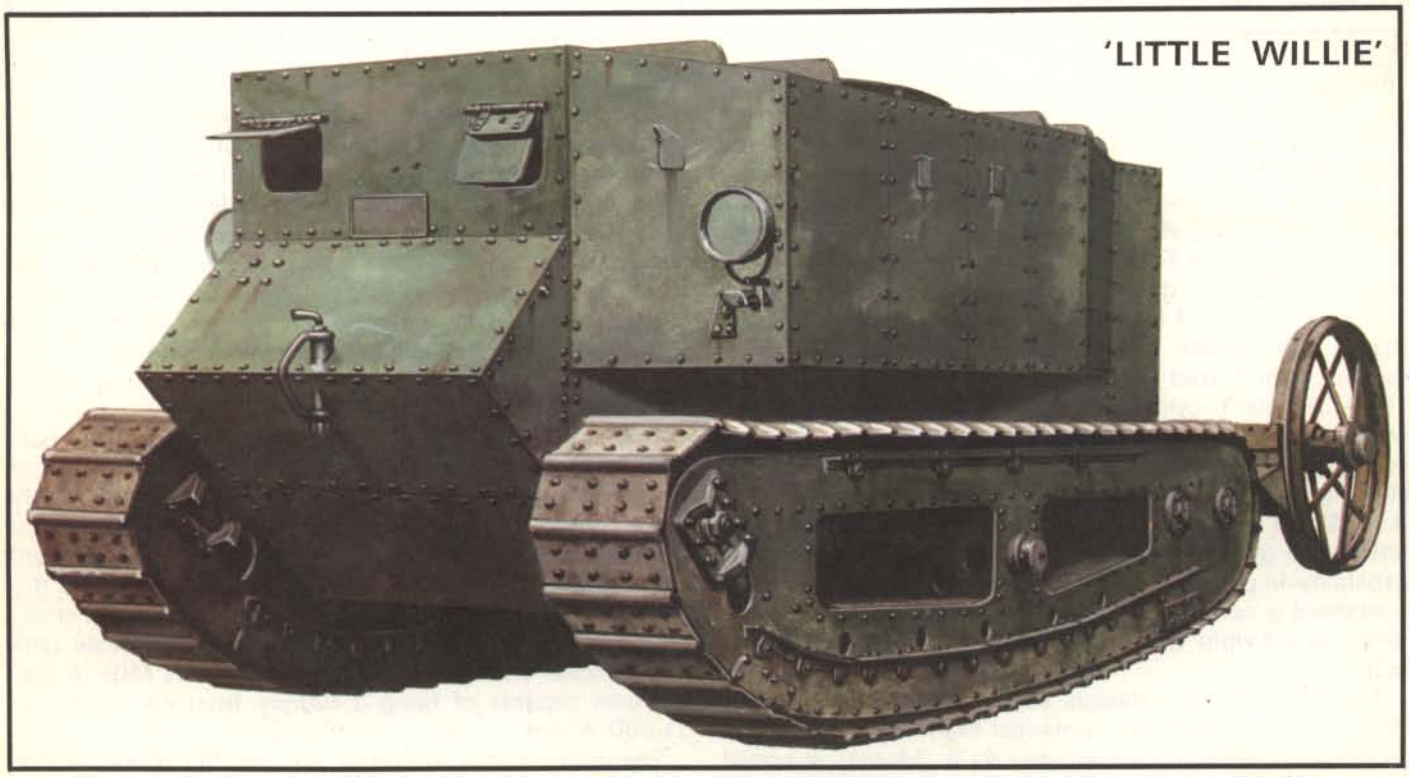
In 1916 Britain led the world in tank development. But her World War II record was one of near failure

Great Britain led the world in tank development and had tanks in action during World War I seven months ahead of any other country. Yet paradoxically it had such a dismal record in World War II, that a secret session of Parliament debated the so-called tank 'scandals' in 1941. Afterwards a top-secret Select Committee delivered a White Paper to the War Cabinet on the shortcomings of British tank development. Why had this glaring contrast between success and failure come about in only 30 years?

The introduction of the tank at Flers during the battle of the Somme on 15 September 1916 was not an inventive stroke of genius, it was a natural evolution. From time immemorial soldiers have endeavored to combine the three attributes of striking power (or firepower), mobility and protection into a single entity. War elephants, chariots and heavy cavalry all had their day of battlefield supremacy but the ever-increasing weight of their protection destroyed mobility and thus their hitting-power. Not until commercial introductions of the internal combustion engine and the caterpillar track were the basic elements of what became the tank available for exploitation. Even so it still required the conditions of military stalemate, as experienced in France and Belgium at the close of 1914 (where the machine-gun, barbed wire and elaborate trench systems brought about conditions of static warfare), to encourage the search for a mechanical solution.

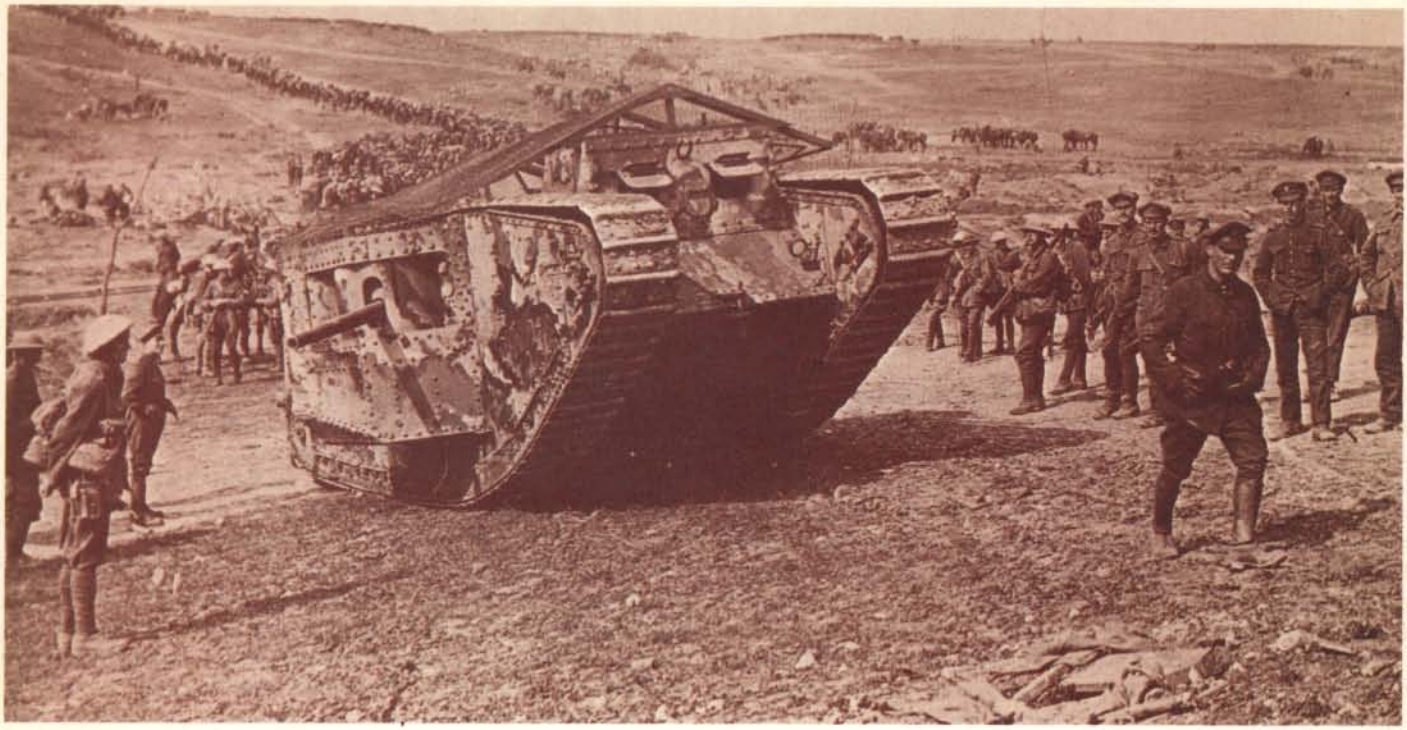
That solution was suggested in October 1914 by Colonel Ernest D. Swinton in the shape of an American Holt agricultural tractor armored as a 'machine-gun destroyer'. But Swinton's suggestion was turned down by the Secretary of State for War, Earl Kitchener of Khartoum. Nevertheless, by lobbying on the 'old boy' net, the scheme came to the ears of the First Lord of the Admiralty, none other than Winston S. Churchill. Churchill's fertile mind inevitably reacted favourably to such a suggestion, because he had already handsomely backed the Royal Navy Air Service (RNAS) Armoured Car Division in their attempts to develop armored cars with an off-road capability.

The Admiralty Land Ship Committee, whose chairman was the Director of Naval Construction, became responsible for tank development from February 1915. All their experimental vehicles were grandiloquently given the initials HMLS ('His Majesty's Land Ship'). When it was appreciated that a track-driven, offensive armored vehicle was a reality, a name was needed that would preserve secrecy until it went into action. The name had to describe the vehicle when



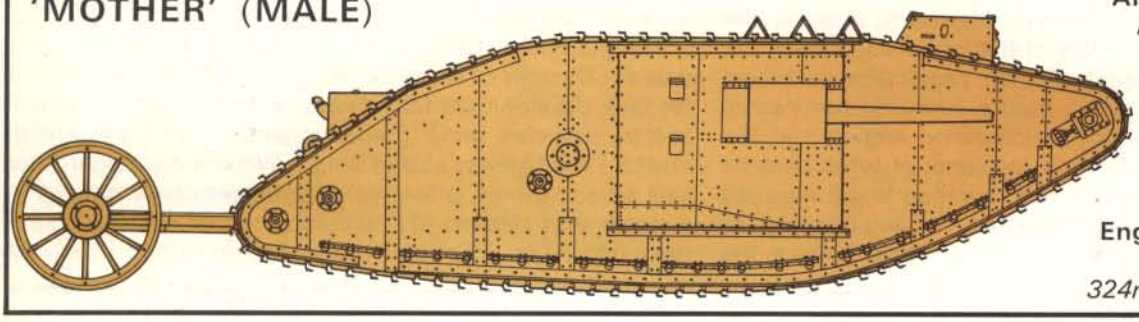
Peter Sarson/Tony Bryan

'Little Willie'. The first AFV, described (for security reasons) as a 'tank'. No more than a 14-ton armor-plate box on tracks, it was planned to put a 6pdr gun in a rotating turret. The resulting high center of gravity prohibited it.



Imperial War Museum

'MOTHER' (MALE)



Armament *Two 6pdrs Four Hotchkiss .303s*
Crew *Eight*
Height *8ft 0½in*
Width *13ft 9in*
Length *26ft 5in*
Weight *28 tons*
Armor *12 to 6mm*
Engine *Daimler 105bhp*
Ammunition *6pdr, 324rnds; MGs, 6,272rnds*

Peter Sarson/Tony Bryan

sheeted up with tarpaulins. Water cisterns or water containers were both thought to be apt but could not be abbreviated. So the simple name 'tank' was coined for the new weapon.

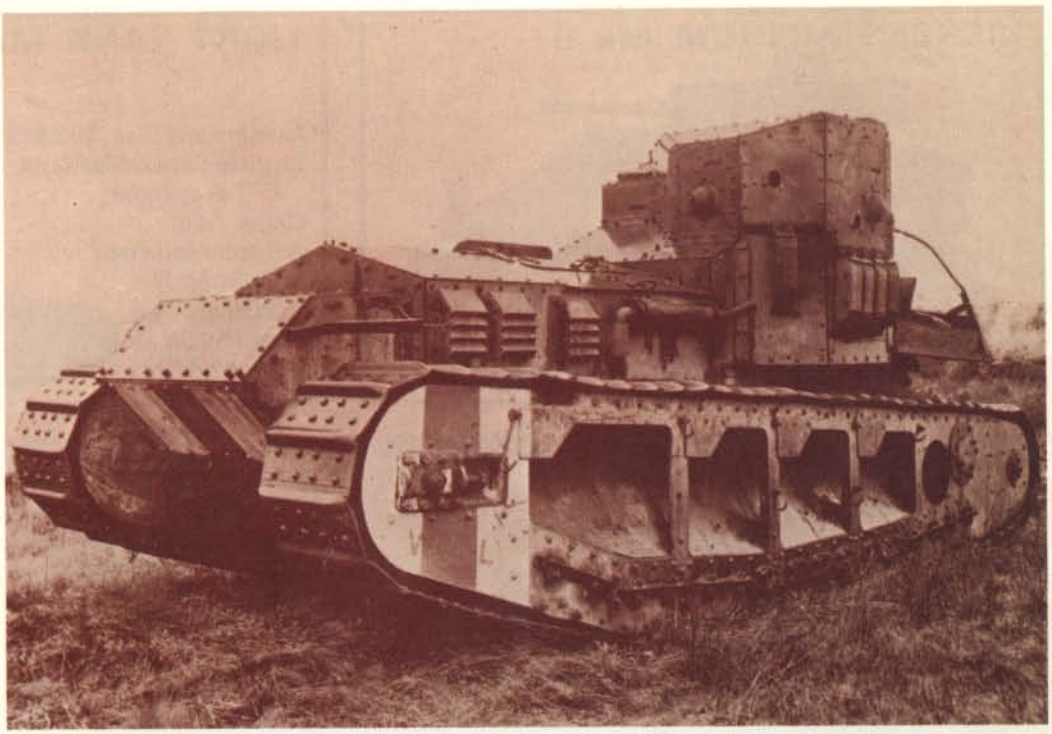
The first tank was the 14-ton Tritton, or 'Little Willie' (satirically named after the Crown Prince of Germany), which was built by Foster Engineering Works of Lincoln in August 1915. The design team consisted of Mr William Tritton, a director of Fosters, and Lieutenant W. G. Wilson, RNAS. 'Little Willie' had tracks running round the hull, a dummy central fixed turret for an unfitted 2pdr gun, and a 105hp Daimler 6-cylinder sleeve-valve water-cooled inline engine. Top speed was 3.7mph. The center of gravity was so high, due to the turret, that wheels were fitted on a steering tail to increase stability and control. In its trials 'Little Willie' was only partially successful. Its low track was unlikely to give the required trench and obstacle-crossing capability. In parallel with the 'Little Willie' design, Lt. Wilson conceived a completely different solution. In it the tracks were carried right round a rhomboid or lozenged shaped hull.

The 28-ton Wilson design, known as 'Mother', or 'Big Willie', had so much more potential than 'Little Willie' that all design effort was concentrated on it. 'Mother' successfully completed trials in February 1916, which included climbing a 5ft parapet and crossing an 8ft gap, within six months of placing the order. A 6pdr (57mm) naval quick-firing gun was mounted on each hull side in a sponson (a naval-type gun casement) and 324 rounds of ammunition were stowed. The crew consisted of eight men, four of whom were involved in driving the tank. In order to change speed or to steer by brakes and secondary gears, the driver had to communicate his orders by signals to the brakeman at his side. The gearsmen who operated the secondary gearboxes which controlled the speed of each track also had to be instructed. It can be imagined how impossible speech was above the tremendous din. A code of hammering on the engine casing and hand signals was devised.

The 'Little Willie' engine was used, giving the same speed of 3.7mph, and a fuel endurance of 23 road miles or an operational radius of about 15 miles. 'Mother' became the Mark I. Marks II and III were practically identical. As the Mark I started production, it was realized that the 6pdr tank would lack the sheer volume and intensity of fire to discourage determined enemy infantry. A man-killing 'Female' tank was adopted as a consort for the 6pdr-gun 'Male' tank. The 'Female' consort had two .303in Vickers MGs in each sponson capable of firing 2,400rpm from no fewer than 31,000 rounds carried.

The initial production order was for 100 tanks. As they were built they were shipped out to France for trials and crew training. General Sir Douglas Haig, C-in-C of the BEF,

◁ The tank's debut in battle, 15 September 1916. Of the 49 Mk Is assembled at the battle only 32 reached the start-line. Of these, 18 went into action with considerable effect. This Mother is a 'Male', with a 6pdr gun either side.
▷ Demand for faster tanks resulted in the Medium A Whippet. This was powered by two Tyler 45bhp engines which gave it a breakneck speed of 8mph. Each engine drove one track, which made control of its 14 tons difficult. The crew of three had four Hotchkiss .303 MGs, for which 5,400 rounds of ammunition were provided.



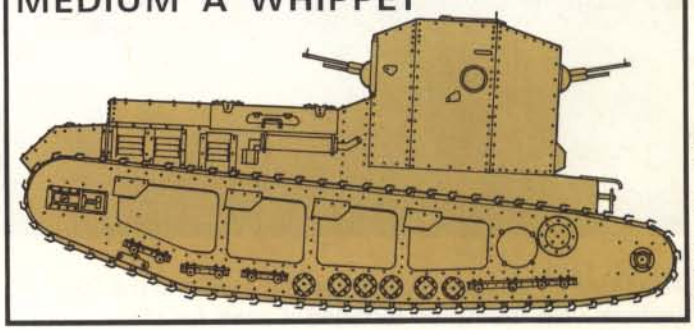
Imperial War Museum

was so desperate to see results from the abortive battle of the Somme, then 10 weeks old, that he threw in all the available tanks on 15 September 1916. Forty-nine out of the 60 tanks in France were fit: 32 reached the startline; nine broke down, five became ditched but the remaining 18 gave a good account of themselves and their appearance shook German morale to the core. 'The Devil is coming!' was the cry that spread like wild-fire along their trenches. One tank broke into the village of Flers, followed by English and New Zealand infantry and captured 300 Germans. Open country had been reached but as always reserves could not get up in time to exploit the fleeting moment.

This use of tanks prevailed until the battle of Cambrai on 20 November 1917. Colonel John Frederick Charles Fuller, visionary advocate of armored warfare and operations planner at Tank Corps Headquarters in France, proposed that a tank raid should be launched near Cambrai. This area chosen consisted of rolling chalk downs, not unlike Salisbury Plain, and had not been much fought over. There was to be maximum surprise and no preliminary artillery bombardment. Every available tank was used—476, including 100 supply tanks (the old Marks I-III), carrying fuel, ammunition and defense stores, wire-clearing and wireless tanks. Gains were made over a seven-mile front to a depth of more than five miles and the much-vaunted Hindenberg Line was breached. In 12 hours the Mk IV fighting tanks spearheaded a deeper advance than that made in 10 weeks of fighting on the Somme. Hundreds of guns, mortars, MGs and 8,000 prisoners were captured. For the first and only time in World War I the church bells of London pealed for victory.

Unfortunately, celebration was premature. The breakthrough was not exploited by four cavalry divisions despite the fact that on the first morning two tank company commanders rode into Cambrai on a mule and a horse without mishap! Insufficient reserves were available to expand the break-in or even hold the gains, and eventually German counter-attacks regained most of them. But what Cambrai did do was to establish the tank, even in the minds of the

MEDIUM A WHIPPET



Peter Sarson/Tony Bryan

Jeremiahs, as a potent weapon of war.

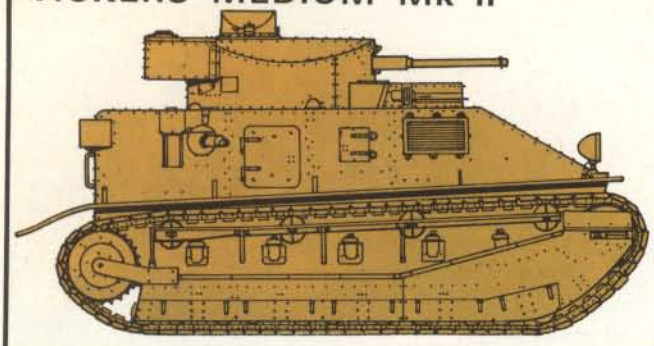
In January 1918 the Mark V went into production—the October 1917 redesign of 'Mother'. It had a more powerful Ricardo 150hp engine, specifically designed as a tank engine, which gave a speed of 4.6mph and a 40-mile road range with a 25-mile radius of action. Armor thickness was increased to 14mm (0.55in) and maneuverability was dramatically improved by Wilson epicyclic steering. The tank could now be driven and controlled by one man instead of three. Unfortunately the radiator was installed inside the hull for protection, and this resulted in poor ventilation. All heavy tanks suffered from engine and cordite fumes, but the Mark V's carbon-monoxide pollution gave the crew severe headaches and sickness. Temperature in the cramped fighting compartments of early tanks could reach 100°F (37.8°C), limiting the crew's endurance to a matter of hours.

The last big tank battle of World War I was the battle of Amiens on 8 August 1918 ('War Monthly', Issue 11) where 420 fighting tanks and 120 supply tanks were used to open the final offensive of the war. Though established, the early heavy tank had lacked the range and numbers to be a strategic war-winning weapon on its own.

Tank production ceased after the Armistice, but in the meantime the Master General of Ordnance had ordered a medium tank from Vickers Armstrong Ltd. without the General Staff's knowledge. General Staff were faced with a

1

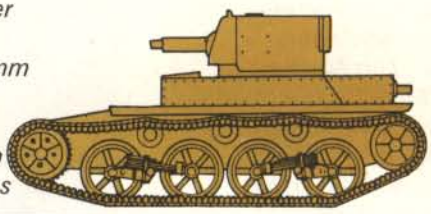
VICKERS MEDIUM Mk II



2

LIGHT TANK Mk I

Armament *One .303 MG*
Engine *58bhp Meadows EPT 6-cylinder*
Crew *Two*
Armor *4 to 14mm*
Height *5ft 7in*
Width *6ft 1½in*
Length *13ft 2in*
Weight *4.8 tons*



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1 *Vickers Medium Mk 11** an improved Mk II, which included an armored housing for the radio.*
◁ A development of the Light Mk I (**2**)*, this Mk V had a re-designed turret for the commander and carried a third crew-man. The Mk VI was basically similar but the turret was again re-designed to accommodate a No 7 radio. It was the last model of the Carden-Lloyd series which began as the tankettes. The Mk VI entered service 1936.*

fait accompli, because money voted for tanks in the 1921-22 financial year would be forfeited if used for them. Consequently the Vickers Medium Marks I and II came into service in 1923, remaining there until 1939. It was the first fast tank in the world with a speed of over 20mph, attained by a 90hp Armstrong Siddeley 8-cylinder air-cooled engine. The Vickers mounted a 3pdr (47mm) gun firing AP and a co-axial MG in a 360° traverse turret. Only weighing 12½ tons, the tank's 8mm armor was not proof against small-arms ammunition. The Vickers Medium 1931 looked like a square box on tracks, but this was the tank used to develop armor divisional tactics in 1927-31 during British Army maneuvers on Salisbury Plain. Ironically it was the Germans who were first to apply them in Poland and France during 1939-40.

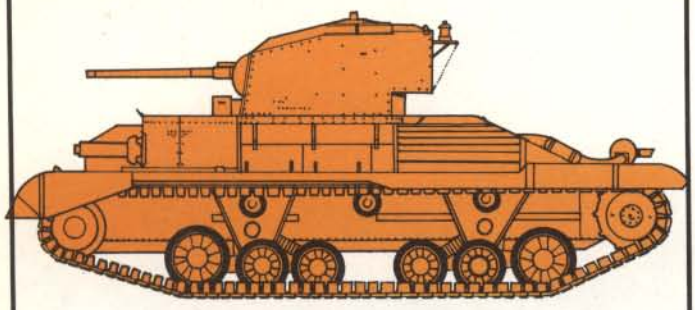
Having acquired a medium tank, the next General Staff requirement was for an assault tank, with heavy armor and an ample trench-crossing capability. In 1925 Vickers designed the 'Independent'. It weighed 31½ tons, had a speed of 20 mph,and carried 25mm (1in) of armor with a 12-cylinder Armstrong Siddeley 398hp engine. Armament was a 3pdr with a co-axial MG in a central turret. The 'Independent' was unique because of four MGs mounted in sub-turrets at each corner of the hull. Apart from the inadequate main armament, the 'Independent' was an advanced design which inspired several foreign multi-turreted designs. But the unit cost of over £12,000 horrified the Treasury into involving the League of Nations Convention prohibiting tanks weighing more than 16 tons.

From 1919 until re-armament began in 1936, priority was given to equipment for colonial wars, the British Army's main operational commitment. This, coupled with the financial stringency, meant that light tanks or armored cars were more likely to reach production than heavier equipment. They were cheaper and absorbed less manpower than heavier tanks. The first light tank was the 1930 Mark I. It had a crew of two, weighed 3½ tons and was powered by a 6-cylinder Meadows 58hp engine which gave a speed of 32mph; one MG was carried in a turret. The Mark I was progressively improved through six more marks down to 1938.

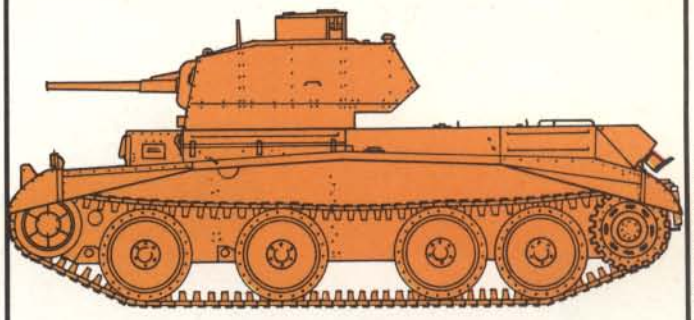
The Mark VI (238 out of 338 British tanks in France in May 1940 were of this type) weighed 5 tons, had a three-man crew. Its 89hp Meadows 6-cylinder engine gave a top speed of 35mph. The light tank had a 15mm BESA or .5in MG with a co-axial .303in Vickers. Armor thickness varied between 4 and 14mm (0.15-0.55in). The Horstman suspension with inclined springs cradled a front engine and front sprocket drive, carried through a bevel cog wheel to a steering clutch to each track. This steering method was alarming because if one steered on overrun after breaking the drive, the tank went into reverse by swinging the free track round the driven portion.

In action these light tanks proved ineffective. They did not have the armor to live on the modern European battlefield and having no gun armament meant that they were held up by the lightest AT weapon. On the other hand they were used in India from 1936 where their ability to operate on the mountainous NW Frontier confounded the sceptics.

3 **CRUISER Mk I (A9)**

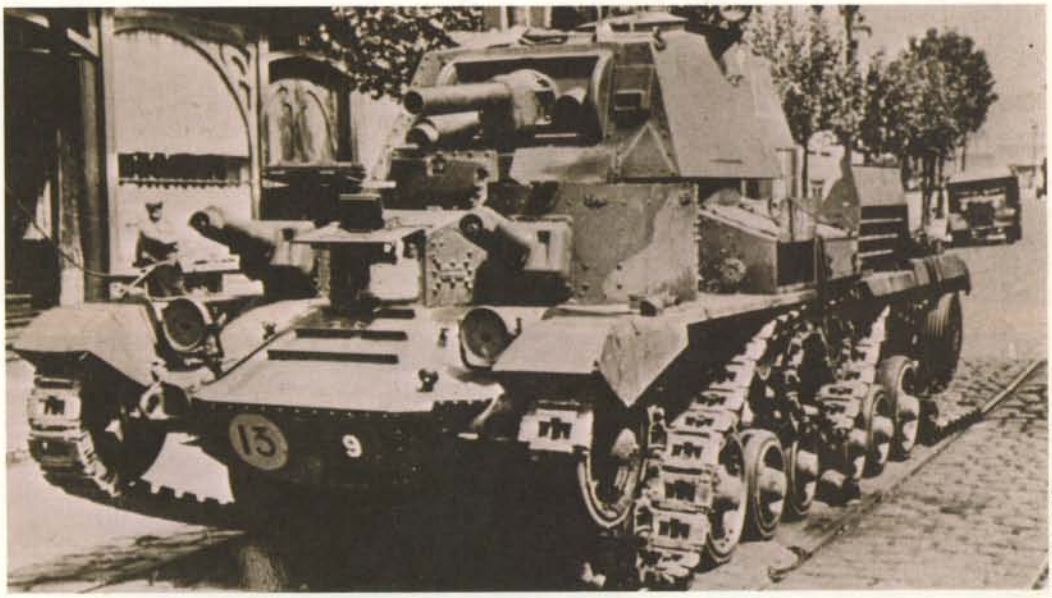


4 **CRUISER Mk III (A13)**



Peter Sarson/Tony Bryan

3 *The Cruiser Mk I (A9) was the result of work by Vickers in 1936. A variant, the Mk I CS, carried a 3.7in howitzer instead of the 2pdr.*
▷ *A Mk I CS knocked out in the streets of Calais during the 1940 defense.*
4 *The Cruiser Mk III was the first British tank to have US-designed Christie suspension. Its speed of 30mph-plus was a notable feature.*
Armament *One 2pdr, 1 MG*
Engine *Liberty 340hp*
Crew *Four*
Armor *14 to 6mm*
Weight *14 tons*



Bundesarchiv

Light armor and armament were sufficient against the tribesmen's weaponry.

By 1934 a replacement for the Vickers Medium was sadly overdue. The specification for its successor called for a simpler and cheaper model (than the 18¾-ton Mark III abandoned in 1931) weighing about 10 tons and using a commercial engine. The A9 (Cruiser Mk I) was the 1938 outcome. At 12½ tons it mounted the new 2pdr (39mm) gun which although smaller than the 3pdr had a higher velocity giving a better AP performance. The AEC 150hp 6-cylinder engine could achieve a speed of 25mph. The A9 was the first tank to use hydraulic power traverse for its turret. There were Vickers MGs in round sub-turrets either side of the driver. A crew of six and 14mm of armor were carried.

Shortly after the A9 design started, a more heavily armored tank was required for infantry support. Sir John Carden was asked to fit 30mm (1.2in) of armor on an infantry support version, the A10, designated Cruiser Mark II. Unfortunately Sir John was killed in 1935 in an air crash. Development was delayed and production only started in 1937. Before A10 development was complete, there was yet another policy change.

Sir Hugh Elles, who, in the Mark IV 'Hilda' had led the Tank Corps into battle at Cambrai—the first tank general to be in the forefront of an armored battle—had been appointed Master General of Ordnance in 1934. He insisted that the infantry tank's armor should be impervious to the German 37mm AT gun, but the tank need only move at infantry pace. Carden replied that he could build a tank with 60mm (2.36in) of armor for £6,000. The result was the Infantry Tank Mark I or 'Matilda' as it was christened by Elles. Matilda weighed 11 tons and was powered by an 8-cylinder 70hp Ford engine with a speed of 8mph. It had 60mm of armor, a crew of two and was armed with a .303 or .5in Vickers MG (4,000 rounds) : 139 were built.

The Matilda was nothing more than a well-armed MG carrier, unstoppable maybe, but totally lacking in speed or punch. The specification for a successor was given in November 1939 before it was even in service. The Infantry Tank Mark II (A12) design was undertaken by the newly formed Mechanisation Board. Hull design was based on an abortive medium tank, the A7 of 1929-37. The Infantry tank Mark II weighed 26½ tons and carried a 2pdr and a co-axial .303in Vickers or 7.92mm BESA MG in a turret with hydraulic power traverse. Clad in maximum 78mm (3.07in) armor, it was the world's most heavily armored tank. Two AEC or Leyland diesels, the first in any British tank, gave 190hp and 15mph. All engines in the five marks had a Wilson epicyclic pre-selector gearbox and steering was by Rackham clutches and brakes. The A12 had a high ground pressure, making it an indifferent performer on soft ground. When Matilda went out of production, in August 1940, the Mark II inherited its name and 2,987 were produced, many hundreds going to Russia during 1941-42.

The Mark II did not lend itself easily to mass production and required excessive crew maintenance, but the heavy cast armor was proof against German 37mm and Italian 47mm AT guns. When the Germans introduced the long

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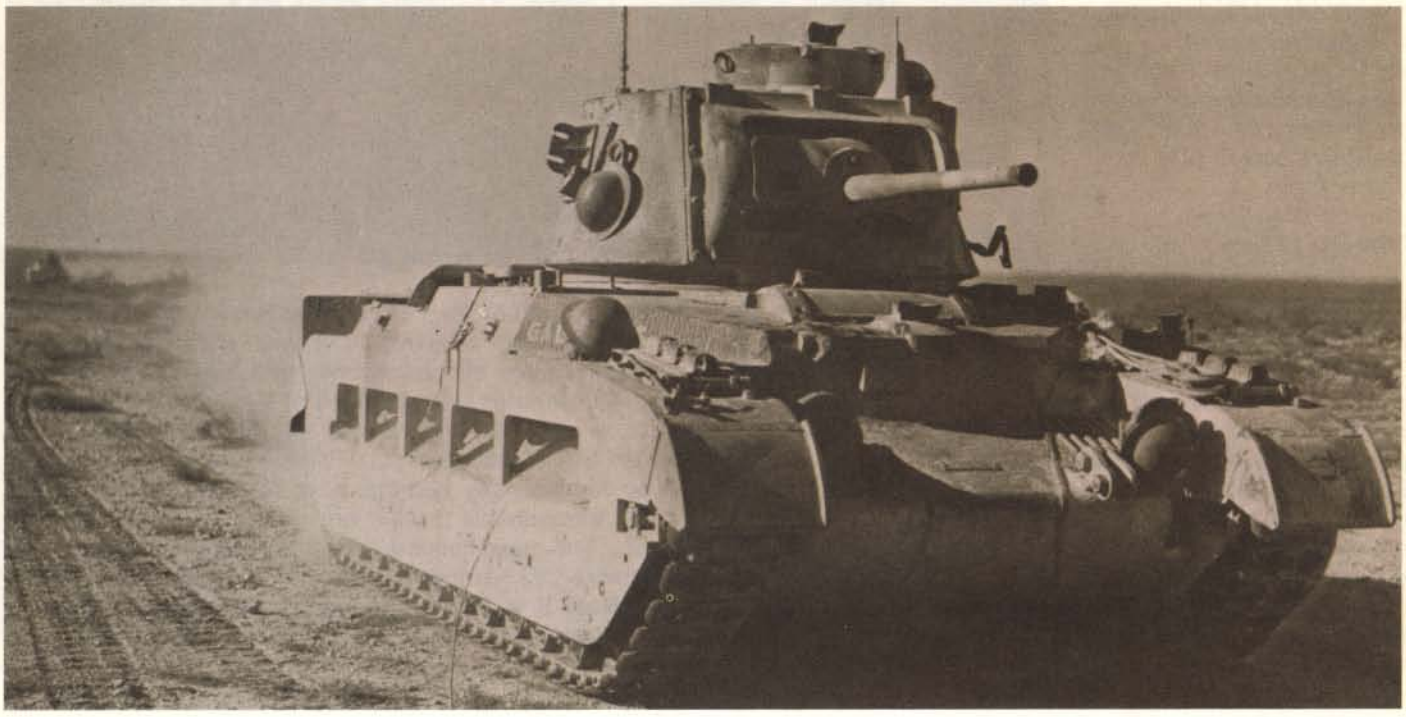


Imperial War Museum

50mm and 75mm PAK guns in 1941, and consistently used the 88mm flak gun in the AT role, the Matilda was at dire risk. However, the 'Queen of the Battlefield' was largely responsible for the incredible success of General Sir Archibald Wavell's 'Thirty Thousand' during the first desert campaign. At Arras in 1940 a mere 16 Matilda IIs demonstrated firepower and speed while their predecessors could only claim some of their invulnerability, gave a severe jolt to the German High Command, hit Rommel hard in his first clash with the British, and immeasurably contributed to the evacuation of the BEF at Dunkirk ('War Monthly' issue 10).

After having not a single battle-worthy tank during the Munich crisis a year before, Britain entered World War II with good but woefully few (67) infantry tanks. The light tank, while inadequate had at least been tried and tested over many years. It was the Cruiser or medium armored department, the projected bulk of tank strength, that was in the most parlous state for the first half of the war. Having settled on the A9, the War Office were galvanized into further action by reports brought back from 1936 Red Army maneuvers by Generals Wavell and Martel. They had seen the 45mm-gunned Russian BT7, Bystry Tank ('Fast Tank'). Capable of 35mph, its 14 tons had jumped off a 5ft bank and cleared 30ft without damage to tank or crew. This agility was attributed to Christie suspension which the Russians had acquired from the US designer Walter Christie. Lord Nuffield was persuaded to acquire the patent rights and buy a Christie tank, which was shipped from America

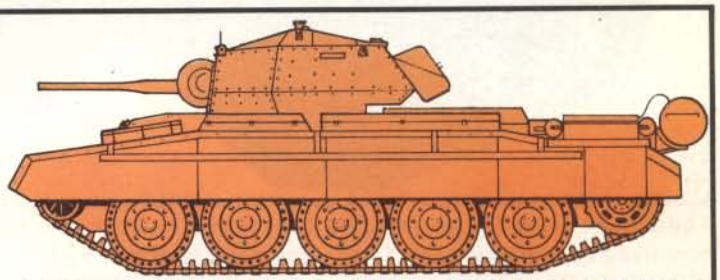
E. C. P. Armée

◁△ *Early Cruisers had been too slow, and so parts used for the Cruiser Mk III (A13) were used for a Mk V Cruiser. This tank, to become known as the 'Covenanter', had many problems, mainly to do with the engine cooling. This version, the Covenanter III had extra cooling louvres at the rear. As usual, this tank was under-gunned.*

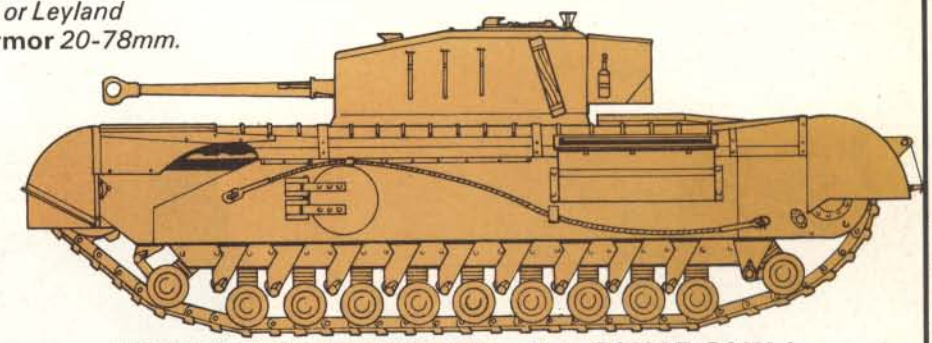
◁ *The Matilda, 'Queen of the Desert', played an important role in the Western Desert fighting. It still carried the small 2pdr, with CS models being fitted with 3in howitzers.* **Engine** *AEC or Leyland diesels;* **Crew** *four;* **Speed** *15mph;* **Armor** *20-78mm.*

△ *By 1941 the Cruiser Mk VI Crusader had appeared. Based on the Covenanter, it also saw considerable service in the desert—and still with that weak 2pdr gun.*

▷ *A tank that saw much successful service in World War II, the infantry Tank Mk IV Churchill.*



CRUISER Mk VI (A15) CRUSADER



INFANTRY TANK Mk IV CHURCHILL

Peter Sarson/Tony Bryan

as a tractor and the spares as grapefruit, in order to overcome US export regulations.

The Cruiser Tank Mark III (A13) was designed by the Mechanisation Board in late 1936 to incorporate Christie suspension; big wheels independently sprung with large wheel movement to give a remarkably good and smooth ride. The A13 weighed 14¾ tons and was powered by a 340hp US Liberty/Nuffield aero-engine. This power unit was to have driven the joint Anglo-American 'Liberty' tank project of 1919 (only four of these British designed, Mk VII, tanks were produced by Armistice Day). The A13 suspension had to be redesigned because the components were not strong enough for the extra four tons of weight over the Christie unit's 10 tons. A13 had 14mm of armor, i.e. the thickest skin of a World War I tank, and a 2pdr gun with co-axial MG. The tank was most unreliable and the engine gave constant trouble as did every Liberty engine used in later Cruisers. The A13, developed in under two years, ran to three Marks, the Mark III being uparmored to 30mm (1.18in).

For the French campaign of 1940 the A9, A10 and A13 went belatedly into action. A9 and A10 were comparatively reliable. During the Fall of France the only tanks in the British Army that fought with weapons larger than a machine-gun, were 28 Matilda IIs and 158 Cruisers Mks I, II, and III (in 1st Armoured Division). All equipment in France was lost and there were only 50 tanks in England. Every tank produced after Dunkirk went off the assembly-

INFANTRY TANK Mk III VALENTINE

Armament (*Mk I-VII*)
One 2pdr
One 7.92 Besa
Engine *AEC 2 x 87bhp*
Ammunition *6pdr 60 rds*
7.92 3,150 rds
Crew *3-4*
Height *7ft 5½in*
Width *8ft 7½in*
Length *17ft 9in*
Weight *16 tons*
Armor *8 to 60mm*

Peter Sarson/Tony Bryan

The chassis of the Cruiser Mk IIA (A10) was used for the Vickers-built Valentine. After just a year's work, the prototype appeared in early 1940. Four years later 8,275 had been built. It was up-gunned from a 2pdr to a 6pdr.

Imperial War Museum

A Valentine commander, microphone in hand, navigates from the turret of 'Divine Discontent'. The Valentine had a number of 'special' roles, as a swimming tank, flame-thrower (cordite and gas-operated) and mine-clearer.

line straight to field units. No modifications or new designs were allowed, nor did time allow engineering trials or tests on equipment under development. The demand was for quantity at the expense of quality. Until well into 1941 the only types produced were Matilda II, Valentine and Covenanter (Cruiser Mark V). The Churchill was then in the design stage.

None of these tanks could be fitted with a larger gun than a 2pdr because of the diameter of the turret ring. That was limited by the width of the tank which was dictated by a 9ft rail transportation limit. The 1943 Cromwell, with a width of 10ft, was the first to break this rule.

When the A13 Cruiser entered service in 1939, 14mm of armor was already insufficient. The 7 to 40mm-skinned Covenanter, developed from A13, came into production that same year. Markedly unreliable, although over 1,000 were built, and fit only for training, it was very frustrating even in this role. The Crusader (A15) Cruiser Mark VI successor was designed by the Mechanisation Board before July 1939 and ran to three Marks with armor of between 40 and 51mm. In Marks II and Mark III, Crusader's front auxiliary MG turret was used to store extra ammunition. Consequently, the Crusader could carry more main armament shells (110) than any of the previous fighting Cruiser tanks. The 1942 Mark III Crusader mounted a 6pdr (57mm) gun but this cost the co-axial MG as well and so it became nothing more than a self-propelled AT gun. The Crusader had Christie suspension, a 340hp Nuffield Liberty engine, weighed 19 tons and could manage 27mph. Used as the principal tank in North Africa from June 1941 until El Alamein, its exceptionally good ride and cross-country speed were most impressive. But that did not out-weigh it being under-gunned and under-armored.

Valentine—the 'compromise' Cruiser

The last pre-war tank design was the Valentine. This compromise Cruiser Infantry tank design was a private Vickers effort, developed without an Army specification. Submitted to the War Office on St. Valentine's Day (14 February) it was turned down. But second thoughts prevailed and a July 1939 contract was placed for unlimited numbers. By a coincidence the prototype was also ready on St. Valentine's Day, 1940. The Valentine saw action almost exclusively in North Africa and proved itself the most mechanically reliable British tank; 3,000 miles of desert operation before overhaul was not abnormal. Over 8,275 Valentines were produced, the highest total for any British tank.

The Valentine weighed 16-17 tons, with a 135hp AEC diesel engine and a speed of 15mph. It had 65mm (2.56in) of armor welded as well as riveted. A 2pdr and co-axial BESA 7.92mm MG were manned by a crew of three. Although it ran to 11 Marks, only the 2pdr-gun type saw action. The Valentine economically used the same transmission and suspension as the A9 Cruiser. Nearly 3,000 Valentines were delivered to the Russians, who reckoned them the best of the some half-a-dozen British tank types (deliveries totalled 4,260) they received. The Valentine's drawback was the inevitable 2pdr gun and the two-man turret involving the commander in loading and clearing stoppages instead of directing his tank.

The Churchill Infantry Tank Mark IV (A22) was the fourth and last of the 'I' tanks. Its history went back to the A20 of September 1939 which called for a tank capable of crossing obstacles and waterlogged, shelled ground; World War I conditions envisaged in attacking Hitler's overrated Siegfried Line. In June 1940, A20 was abandoned and an A22 specification drawn up by the Director of Tank Design. Vauxhalls were given the design contract. Because of the fear of imminent German invasion, the Churchill came straight off the drawing board into production less than a year after the specification. Inevitably it suffered untold mechanical woes. As late as November 1942, after the first 28 to see action were lost in the disastrous Dieppe Raid, a complete rework programme was required on over 1,200 Churchills. Eventually mechanical faults were overcome. The Churchill mounted a 6pdr and later a 75mm gun with co-axial and hull MGs. It weighed 39 tons and had 90mm (3.54in) frontal and 76mm side armor, a Bedford 12-cylinder engine gave 350hp and a speed of 12-15mph. Merritt-Brown regenerative steering was used and there were 11 road-wheels per track mounted on trailing arms. It had electrical rather than hydraulic power traverse.

Thick-skinned and lovable Churchill

The Churchill was the slowest tank in service, maintenance was excessive, and it had no more powerful gun than any other. But the crews loved it, simply because it was thicker-skinned than any other Allied tank and could absorb tremendous punishment. Indeed its maximum armor thickness was superior to that of many Royal Navy light cruisers. Another bonus was its unsurpassed mountain-climbing ability. In Tunisia, after successive assaults had failed to capture the vital Long Stop Hill, a troop of Churchills waddled to the summit on 26 April 1943 and pinned the enemy down until British infantry could take over. There were no AT defences in the position because the Germans considered it tank-proof. In all, 5,000 Churchills were built and the Irish Army were still using the tank in 1968.

From October 1942 at least six prototypes of a new tank design were considered essential. These prototypes were to be tested over at least 2,000 miles before going into production. Although the war was now not going so badly, this sounded the death-knell to the 'off-the-drawing-board order', which had proved disastrous mechanically for the Churchill, Crusader and Covenanter.

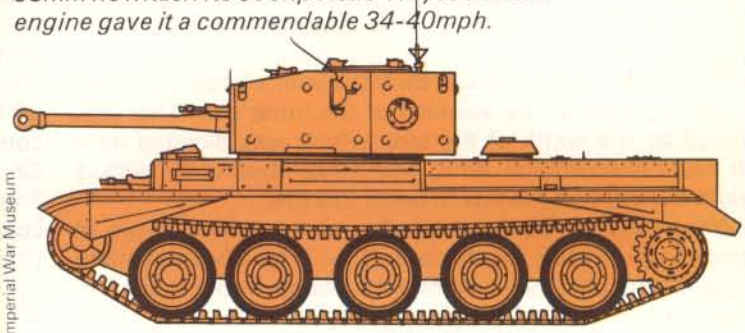
In June 1941 a specification was issued for a new Cruiser tank with 75mm of frontal armor and mounting a 6pdr gun. From this requirement stemmed the Cruiser Mark VII Cavalier (A24) and the Cruiser Mark VIII (A27) in two versions; the Centaur with a Liberty engine and the Cromwell with a Meteor engine. Cavalier appeared in early 1942 the last order straight off the drawing-board. Underpowered and unreliable, Cavalier and Centaur, both derived from the Crusader, died natural deaths as training machines or in specialist conversions.

Cromwell, which came into production during 1943, was more promising. It had the most powerful engine yet put into a British tank—a 600hp Rolls Royce derived from the Merlin aero-engine. This gave an excellent power-to-weight ratio of 22:1. Even the legendary Russian T34 of 1941, weighing almost the same, had achieved only 18:1. Its road range of 165 miles was the longest yet achieved by any operational British tank. Merritt-Brown gearbox and controlled differential steering made Cromwell fast and maneuverable, with a speed of 38mph. This proved too high for the Christie suspension and speed was reduced to 32mph on the second major variant, the Mk VII. The 6pdr was replaced during production, by the same Mark V 75mm

CRUISER Mk VIII CROMWELL

At last a fast and well-armed British tank. This is the Cruiser Mk VIII Cromwell, armed with a 95mm howitzer. Its 600hp Rolls-Royce Meteor engine gave it a commendable 34-40mph.

Imperial War Museum



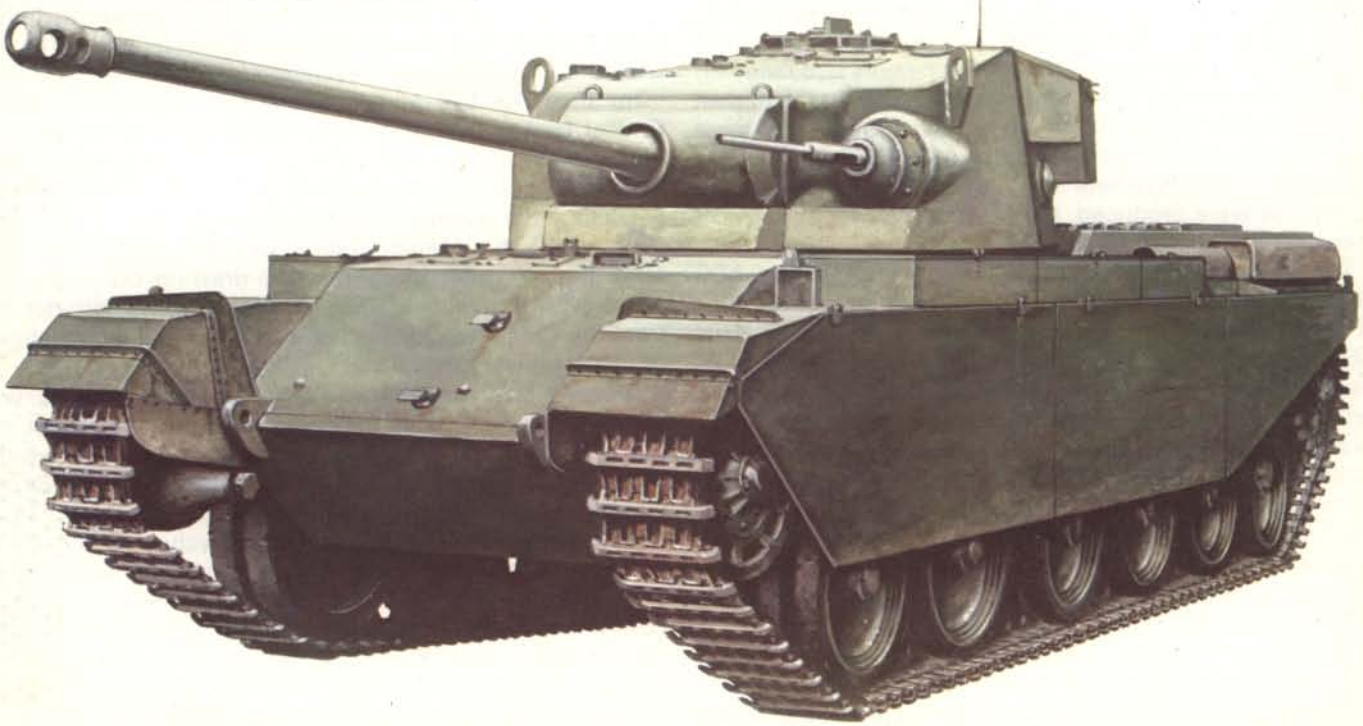
Imperial War Museum

◁ By 1945—and about time, too—British tanks were designed with ample calibre guns. The Comet based on the Cromwell, chassis, had a 17pdr (77mm) gun, Armor was 14 to 101mm and its Meteor engine drove it at 29mph.

▽ Development of the Centurion (A41) began in 1943. Starting with a 17pdr (76.2mm) gun, so good was this design that later marks used 105mm guns.

▷ Israeli Centurions.

CENTURION Mk I



Peter Sarson/Tony Bryan

tank gun that equipped the Churchill and the US-designed Sherman.

The Cromwell fought in NW Europe from D-day onward. It was not possible to fit a more powerful gun than the Mk V 75mm. So, although the fastest and most agile tank in service, forming about 20 per cent of 21st Army Group's armored strength, Cromwell's gun (with a derisory penetration of 74mm at 100 yards) was no match for the 100mm frontal armor of the German Panther and Tiger tanks. Worse, the gun itself was inferior to the long-barrelled 1942-vintage 75mm KwK 40 on the *Panzer* Mark IV, a type in production since 1936. The war had less than a year to run and Britain was still without a tank that combined firepower, speed and protection in the right balance for a fighting machine of real quality.

The next Cruiser, the Comet (A34) from Leyland was an attempt to provide the vital ingredient of hitting power. Leyland's experience with Cromwell stood them in good stead and their new design was accepted in July 1943. It mounted the 77mm shortened-barrel version of the successful 17pdr AT gun. Production was given some priority in an attempt to field the Comet in 1944. It arrived in NW Europe during December 1944. Comet was very similar in layout to Cromwell. It was of all-welded construction like later Cromwell VIIs. The Meteor III engine gave a speed of 32mph for a weight of 35 tons. Unlike its Cruiser predesecssors, Comet had electrical power traverse. Apart from the Borg and Beck hydraulically operated clutch and four track-support rollers on each side, it was similar automotively to Cromwell. The turret front armor was an impressive 100mm (3.93in) and all the Cromwell suspension units were strengthened. Had Comet appeared two years earlier it could have been a match-winner. As it was, it did post-war service in Berlin and Hong Kong until the late 1950s.

In August 1943 the Director of Tank Design started development on the A41 Centurion, a *heavy* Cruiser tank. This was to have a gun that could defeat the Tiger's armor, and enough protection to cope with the vaunted 88mm. The Centurion's gun, initially a 17pdr, was to be replaced by the new 20pdr (84mm). An unrealistic weight of 40 tons was specified; the actual weights of the 13 different Marks of Centurion varied between 47 and 51 tons. Novel design features were a sloped glacis plate; 152mm (5.98in) basis frontal armor; a 650hp Meteor IV engine giving a governed speed of 21½mph, high and low reverse speeds; and an auxiliary charging engine. The modified Horstman suspension, first seen on the light tanks of the 1930s, was protected by anti-bazooka skirting plates.

Centurion was the first tank in the world to have its main armament stabilized in both lateral and vertical planes, for firing on the move. Any tank movement results in a change of heading or pitch, or both. Such changes move the gun off the target in line and/or elevation. But the gyroscopes in the electro-servo stabilizer drive the gun back to its former position through amplified signals passed by means of the metadyne generators and servo-motors. The first foreign tank with a stabilized gun was the Russian T54/T55, 10 years later.

The other innovation in fire-control equipment was the reflector-cum-periscope sight, which injects the gunner's point of aim into the commander's sight and so greatly assists the commander in directing fire on to an inconspicuous target. The 20pdr, in its day, was the best tank gun in the world and its 105mm successor retained that lead. It is the gun currently used by the Israelis in their Centurions, as well as the captured Russian T55s and T62s. Six prototype Centurions were sent to NW Europe in May 1945 just too late to see action—the ultimate yardstick of the failure in British war-time development.

Eric Offord

Israeli Defence Forces

SUEZ 1915

Sinai Desert 1915. Turkey moved a large assault force across 140 miles of desert to twist the lion's tail

In the 1973 Yom Kippur War both the Egyptians and the Israelis crossed the Suez Canal. They were not the first to do so—some fifty years before them a Turkish army had marched across the forbidding wastes of Sinai and put men on the western bank of the Canal.

In the middle of January 1915 a Turkish Expeditionary Force of 25,000 men left its base at Beersheba and prepared to cross the Sinai peninsula. Its goal was the Suez Canal—a vital link in Britain's Imperial chain. Djemal Pasha, Commander-in-Chief of the Turkish force, despite his arrogant proclamation as he left Constantinople for the front—'I shall not return until I have conquered Egypt'—should have been under no illusions as to the magnitude of his task.

On the far bank of the Canal there was a British force much stronger than the Turks. Its base was only a few miles to the rear. The Turkish troops would find it difficult to carry sufficient stores across Sinai to maintain an offensive for more than a few days. Yet Djemal considered that the political situation was promising. Agents of the German Baron Oppenheim were busy stirring up a rebellion in Cairo which was timed to break out at the approach of the army of another Islamic Power. In the west of Egypt the Senussi tribes were revolting against the British. Djemal Pasha hoped that the infidels would soon find themselves faced with a holy war, a 'jihad', in their very midst. He had, he believed, already scored a propaganda triumph by the insulting messages he had sent to the British generals, inviting them to come out and fight in the open. Understandably, the British had ignored these suggestions and remained behind their Canal defenses.

They did not commit the error of underestimating their enemy. The contemporary issue of 'War Illustrated' (13 March 1915) said: 'Whatever may be thought of his intelligence and skill, the ordinary Turkish soldier is at least no coward. He can usually die as bravely and stubbornly as men or any race.'

If German agents and the promise of a Turkish invasion could succeed in inciting rebellion in Cairo then Djemal could hope to repeat the exploits of Sultan Selim, the first Turkish conqueror of Egypt in 1517. Even if the hoped-for risings did not materialize, the Turks still reckoned on being able to seize a portion of the Canal and hold it long enough to destroy or block it. At the very least they would be able to sink some of the ships which would be trapped *en route* by the advance. Their hulks would take weeks, perhaps months, to shift. So Djemal took with him nine batteries of field artillery and one 150mm (5.9in) howitzer battery—

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0430 *3 February 1915—the Turkish crossing at Tussum was made with two battalions of 73rd Regt., 25th Division. Ironically they picked one of the best-defended sectors of the Canal. Four infantry platoons of 62nd Punjabis were supported by a 4-gun Egyptian mountain bty., a torpedo boat, and two Vickers MGs (right).*

supplemented by a quantity of mines—to attack the British shipping.

The Turks possessed one other advantage. They had with them as adviser the true architect of the advance to the Canal, the Bavarian Colonel Kress von Kressenstein—'a most excellent and efficient Officer', wrote the German General Liman von Sanders. Von Kressenstein's *forte* was desert warfare.

The German Major Fischer saw to it that the problems of watering man and beast on the trek were overcome. Nature also helped the passage. The winter of 1914 had been exceptionally wet and the force was to find a number of springs and pools of water as it marched towards the Canal and the waiting British. Fischer had charge of 5,000 water-carrying camels. A similar number were loaded with stores and ammunition.

British Intelligence knew of the impending assault but the short range of their available aircraft made early discovery of the direction of the attack difficult. The defenders only had three Maurice Farmans, two Henri Farmans, one BE2a and seven French seaplanes at their disposal. Therefore, Djemal and Kress believed that an element of surprise might be achieved by avoiding the traditional coastal route, which would be under the guns of the British and French navies. Instead they decided to strike across the center of Sinai at the section of the Canal between Lake Timsah and the Great Bitter Lake. This approach would provide the possibility of access to Ismailia. He who controlled that town controlled the Canal. Here were the sluices which would enable the water supply to be cut off from its whole length.

Of the three possible routes—the central, the coastal strip and the Akaba-Nekhl-Suez line—that chosen was the worst watered. Also, none of the routes was at that time more than a camel track. However the central approach via Jifjaffa had the advantages of reasonably firm going and immunity from British naval attack.

To confuse his enemy, Djemal sent out two diversionary columns, one in the north against Kantara, the other to his south towards Kubri. Guided by local Bedouin tribesmen, the main Turkish force crossed central Sinai in two contingents, patiently laying brushwood tracks when the surface deteriorated into areas of sand dunes—sometimes several square miles in extent. It is a tribute to German organization and Turkish doggedness that the force crossed Sinai in 10 days without losing a single man or animal. By the end of January the Turks were poised before their objective. Djemal then issued a flowery exhortation:

'Warriors! Behind you lie the vast deserts; before you is the craven enemy; behind him the rich land of Egypt, which is waiting impatiently for you. If you falter, death will overtake. Before you Paradise lies.'

After this rhetorical flourish Djemal gave his orders and the Turks moved forward.

On the right flank, in the north, a weak force of irregulars and Bedouin was sent with some Turkish infantry detachments to mount a feint attack on Kantara. In the south, a pack battery accompanied the 69th Regiment, 23rd Division, as it moved towards Kubri while in the center 20,000 of the best Turkish troops prepared for the attack. Kress von Kressenstein was with the first group of the central force while his fellow German, the splendidly named Colonel von Frankenberg und Proschlitz, accompanied Djemal Pasha and the crack 10th Division in the second contingent.

Turkish intention undisguised

By now the British were ready for them. Small raids against Kubri (27 January) and Kantara (29th) did not disguise the Turkish intention to thrust at the center. Spies as well as aerial reconnaissance confirmed that the attack would concentrate on that sector. Accordingly, Major General A. Wilson, GOC Canal Defenses, reinforced Serapeum with the 2nd Rajputs.

Thirty-thousand troops, mainly Indian, now awaited the attack along the line of the Canal. The 10th and 11th Indian Divisions were supported by the Imperial Service Cavalry Brigade and the Bikanir Camel Corps. Behind them the 42nd (East Lancashire) Division, Australian and New Zealand contingents and some Yeomanry units lay in reserve. The total overall strength was 70,000 men, but not all were fully trained. The defenders were short of artillery. There were only three batteries of Indian mountain artillery and a battery of Egyptian artillery available in the threatened sector. This deficiency was made up for by stationing British and French warships in the Canal. Eight were eventually used in this role. The most powerful of these were HMS *Ocean*, a *Canopus*-class pre-Dreadnought battleship of 12,950 tons (four 12in, 12 6in and 12 12pdr guns) and HMS *Swiftsure* (formerly the Chilean Navy battleship *Constitution*, bought by the Royal Navy in 1909), 11,800 tons, armed with four 10in, 14 7.5in and 14 14pdrs. Other vessels involved included the *Eclipse*-class second-class cruiser HMS *Minerva* (5,600 tons), the sloop HMS *Clio*, the armed merchantman *Himalaya* and the Royal Indian Marine armed troopship *Hardinge*. *D'Entrecasteaux*, the French cruiser, and the coastguard ship *Requin* were also to be involved. The latter, together with the *Hardinge*, was destined to play an important part in the action on the central sector.

The attack began on the night of 3 February. It was cloudy and the waiting British strained their eyes into a darkness made more impenetrable by the blown sand which stung their faces and against which they had to wrap their rifles for protection. Three posts on the east bank, Tussum, Serapeum and Deversoir—two companies in each—watched for a sign of the Turkish advance. Behind them on the west bank 11 smaller posts, each manned by two platoons, covered the opposite shore—and waited. Among the 62nd Punjabis was a 30-year-old subaltern who was to achieve fame in World War II. The defense of the Canal was his first experience of action ('I remember the first bullet that went over my head, which made me duck damn quickly'). His name was Claude John Eyre Auchinleck.

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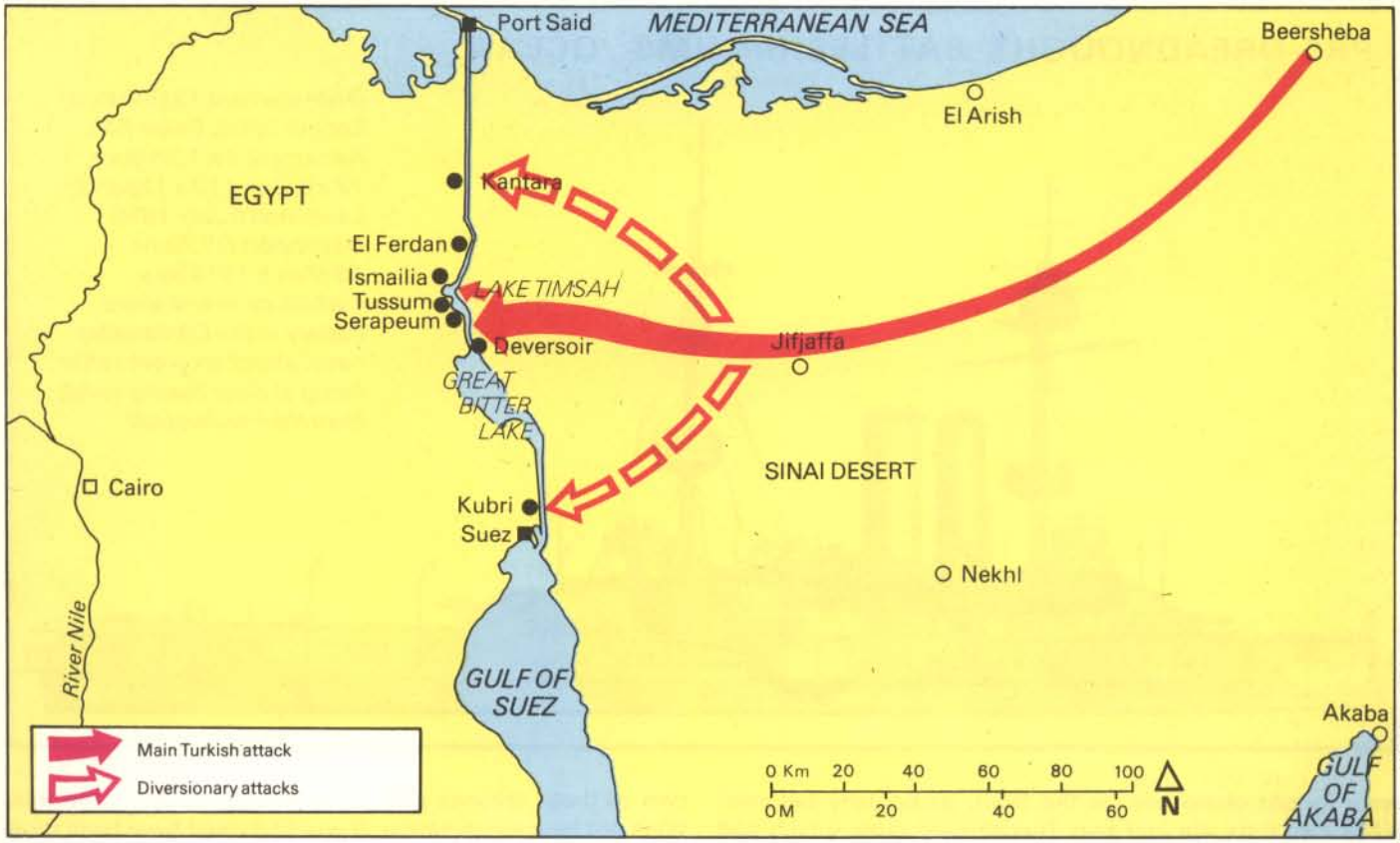
At 0325 Arab irregulars—calling themselves the 'Champions of Islam'—disobeyed orders and gave away their positions south of Tussum by calling loudly upon Allah and cursing the infidel. After sporadic firing on both sides there was once again silence. A little after 0400, the clouds cleared and the moonlight illuminated hundreds of the attackers struggling down to the water's edge, carrying rafts and pontoons. At 0420 this party was engaged by an Egyptian artillery battery and by rifle fire and driven back. Immediately after this, larger groups appeared to the north, near Tussum. These troops tried manfully to launch their cumbersome craft—galvanized iron pontoons and rafts of kerosene tins in a simple wooden frame. Over their heads fierce fire raged between defenders and their own supporting infantry. Three boatloads succeeded in crossing the Canal but were attacked by a bayonet charge from the 62nd Punjabis and the 128th Pioneers. As Auchinleck laconically remarked, 'We were on the west bank and they came over and our men charged down the bank and put a bayonet into them—that was all'. In these engagements every Turkish soldier on the west bank was either killed or captured. At the same time as the Tussum incident the Turks launched a half-hearted attack on the Ismailia ferry post.

Cost of the attack

In the weary dawn the cost of the attack became clear. Turkish dead lay among their abandoned rafts and pontoons on the east bank. The defenders of the east bank outposts sallied forth from their perimeters. More troops crossed the Canal to support them and put paid to any surviving Turk from the eastern margins of the waterway. A torpedo boat was sent north from Deversoir to destroy any pontoons still intact.

But these British counter-attacks were halted by the



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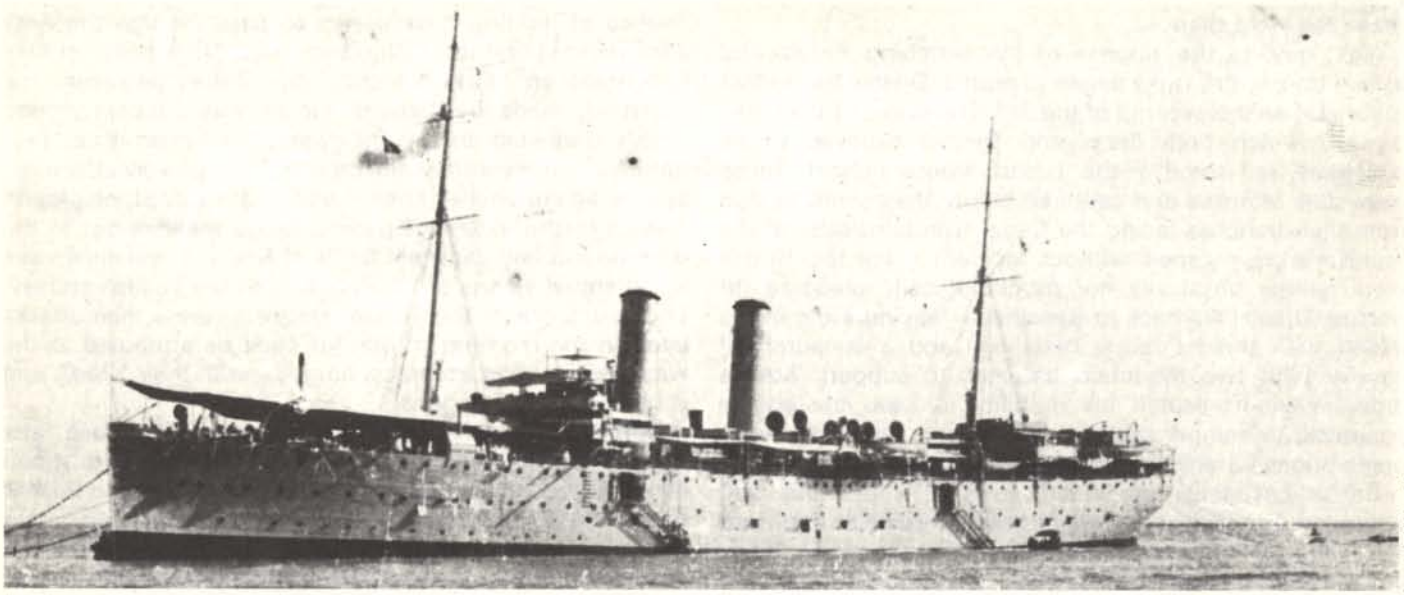


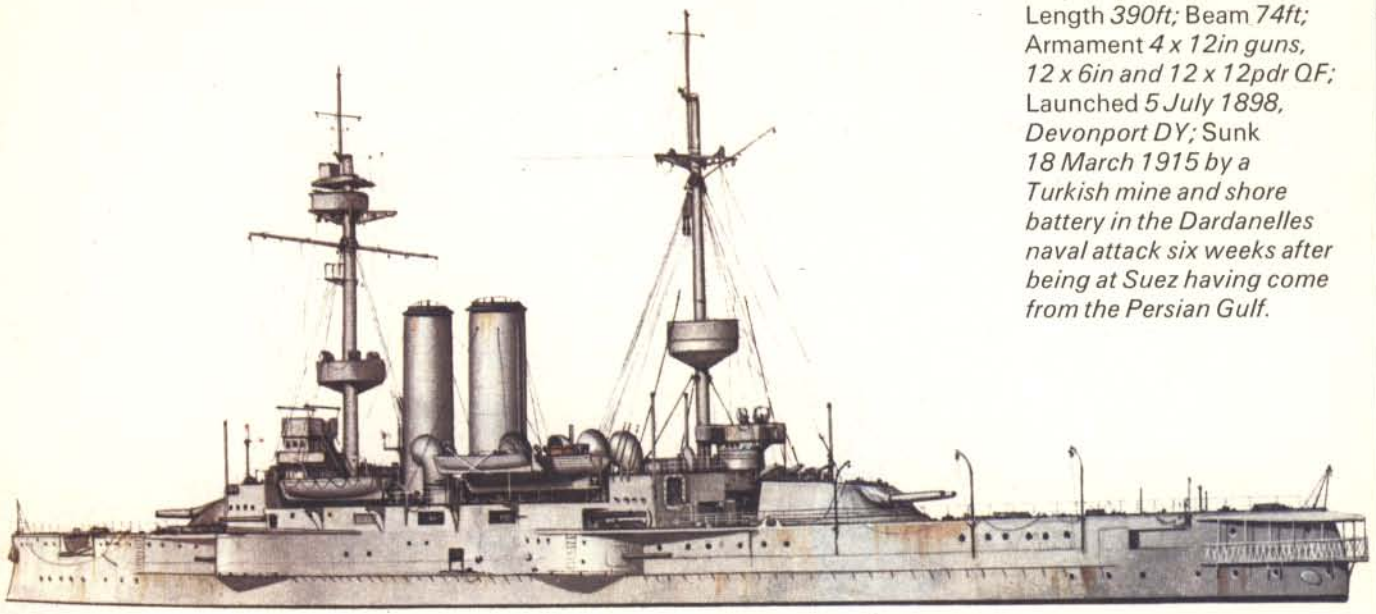
Imperial War Museum

◁△ *Bavarian Col. Freiherr (Baron) Kress von Kessentein, the brains behind the daring Turkish attack on the Canal. One of the pre-war officers on Liman von Sander's Military Mission, Kress rose to command of the Turkish Eighth Army in September 1917 before going to the Caucasus front.*
△△ *For the Turks in 1915 as for the British in 1882 ('War Monthly' issue 5) Ismailia was the vital target on the Suez Canal. It controlled the sluice gates and the Sweet Water canal, sole source of water for Port Said and the other towns, and was the zone's rail junction.*
△ *The Royal Indian Marine armed troopship* Hardinge *had a prominent part in ship-to-shore gun duels that raged for two hours on 3 February. Built in 1900, she had brought Indian troops to Egypt in November 1914.*

appearance of a superior Turkish force. Artillery duels between the ships anchored in the Canal and the Turkish batteries continued throughout the rest of the day.

Here the Turkish artillery was efficient. Two batteries of field artillery and the 150mm howitzer battery succeeded in hitting the outgunned 6,520-ton *Hardinge*, armed only with six 4.7in guns. She was forced to break off action at 0845. A duel now began between the *Requin* and the Turkish battery. At first the Turks had the better of it, but at 0900 their position was betrayed by a puff of smoke. Their range was estimated and their howitzers silenced. *Requin* and the cruiser *D'Entrecasteaux*—ordered up to replace the *Hardinge*—now concentrated their fire on the assumed position of the main Turkish force. Artillery engagements

PRE-DREADNOUGHT BATTLESHIP HMS 'OCEAN'



Displacement *12,950 tons;* Length *390ft;* Beam *74ft;* Armament *4 x 12in guns, 12 x 6in and 12 x 12pdr QF;* Launched *5 July 1898, Devonport DY;* Sunk *18 March 1915 by a Turkish mine and shore battery in the Dardanelles naval attack six weeks after being at Suez having come from the Persian Gulf.*

Peter Sarson/Tony Bryan

were fought elsewhere on the front, particularly between HMS *Clio's* six 4in and two Turkish field guns which had scored some direct hits on El Ferdan railway station. At 1030 these too were silenced.

Next day, to the surprise of the watching British and Indian troops, the Turks began to retreat. Djemal had in fact ordered it on the evening of the 3rd. The speed of the withdrawal, which both Kress and Djemal believed to be necessary, left some of the Turkish troops behind. These were duly attacked and captured before they could escape from their trenches facing the Canal. The remainder of the Turkish army escaped without incident since the British were neither physically nor psychologically prepared for pursuit. Djemal fell back to Beersheba, leaving Kress in the desert with three infantry battalions and a squadron of cavalry with two mountain batteries to support. Kress's orders were to exploit his mobility to keep the enemy occupied, to hamper shipping movements and slow down preparations for any British advance across Sinai.

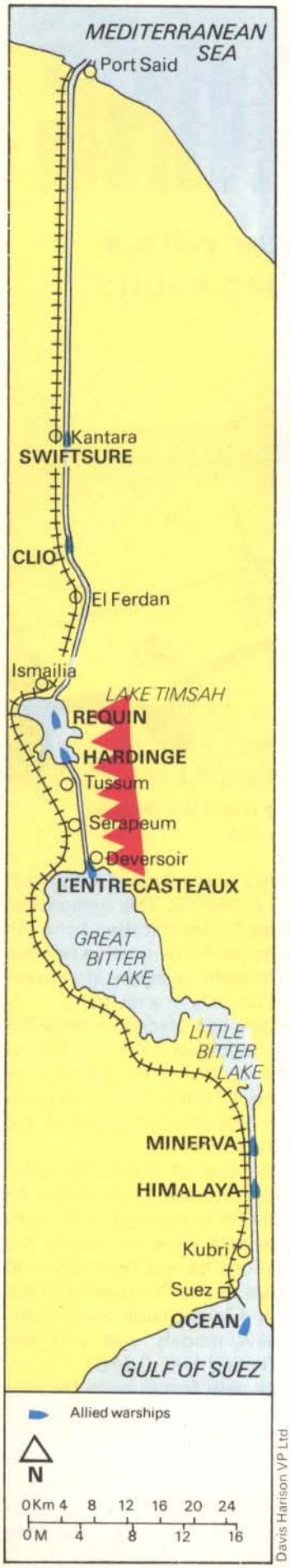
British casualties numbered only 32 killed and 130 wounded. Enemy losses were heavier. Kress gives figures of 192 killed, 371 wounded and 727 missing, a total of 1,290—but the true numbers were higher, since the Turks did not record the casualties of their irregulars. British archives show that they buried 238 of the enemy dead and captured 716 prisoners. One of the dead was the German Staff Officer who had been in charge of the crossing, Captain von dem Hagen.

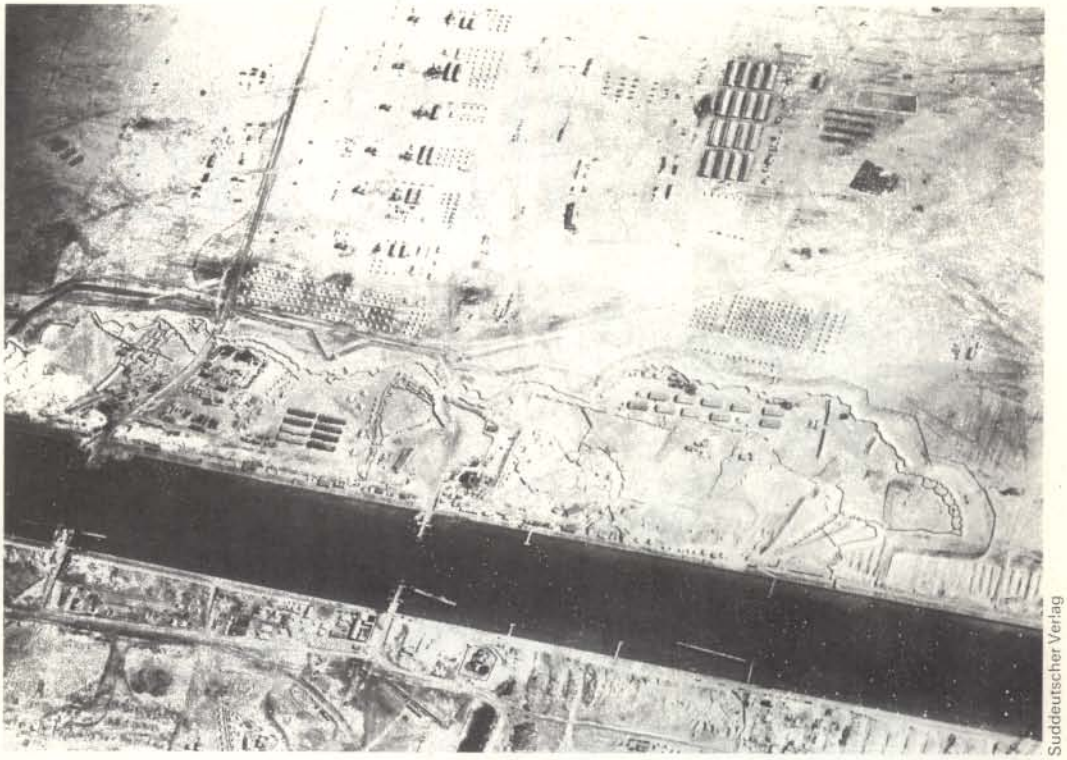
While Turkish expectations of a rising in their favor were certainly over-optimistic, their less-ambitious plan of seizing a section of the Canal for a few days was more realizable. Therefore, their failure to come anywhere near to achieving this objective is puzzling.

Kress claimed that the sandstorm delayed his preparations, that the force lacked the training necessary for a night crossing of the Canal under enemy guns and, finally, that the use of an Arab, rather than a Turkish division was an error—the former's loyalty being suspect. While the first two of these reasons may have some plausibility the third does not bear examination. It would indeed have been more sensible to have used the 10th Division in the first place, instead of holding it in reserve to pass through the Arab 23rd (Homs) and the 25th (Damascus) Divisions after they had made an initial breach in the British defenses. The assertion, made by General Liman von Sanders among others, that Arab units went over to the British is certainly untrue. On the contrary, the crossing was bravely attempted against an entrenched enemy who had prepared the ground—even to the extent of putting range markers out in the desert—and had excellent fields of fire. The warships were the eventual victors of their clash with the Turkish artillery. The reluctance of the Turkish troops to press their attacks later on the morning of the 3rd must be attributed to the warships' shelling accuracy, not least with their 12pdrs and smaller quick-firing guns.

Djemal Pasha and Kress von Kressenstein argued later that the raid had in any case been worth the effort. It had demonstrated the vulnerability of the Canal and had floored British assumptions as to the numbers of men who could cross the Sinai peninsula. In 1906 the British War Office had estimated that, in view of the water situation, the largest force that could cross would be 5,000 men and 2,000 camels. Technically, the expedition had been impressive and this demonstration of German/Turkish expertise made necessary the continuation of a huge British presence—first to defend and then to move out from the area of the Canal. One British commentator, Major General Sir M. G. E. Bowman-Manifold, is generous in his praise for the Turkish achievement:

'The Turkish effort deserves admiration. To bring thousands of men, artillery and pontoon train across 140 miles of desert was creditable; to assault a front defended potentially by 70,000 men and the heavy metal of ships' armament, was audacious: to depart again with artillery and baggage intact, and a loss of not 10 per cent of infantry was clear gain and left the defenders with little to boast of.'

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◁ *Imperial artery—the 107-mile Suez Canal, 65-100 yards wide and 34ft deep. Eight warships were stationed in it to act as floating batteries.*
△△ *'Is the garrison of Egypt defending the Canal or the Canal the garrison of Egypt?' A German photo recce shot of Kantara in 1917, now a vast base for a slow British advance across Sinai to Palestine.*
△ *Djemal Pasha, Minister of Marine and C-in-C 4th Turkish Army with one of his German officers, Col. Frankenberg (left).*

Troops occupied in Egypt—and the next time the Canal was threatened, early in 1916, 400,000 troops were massed to oppose any expedition—were at least kept out of the European theater. This, to von Kressenstein, was reason enough for the original attack. Djemal had escaped without serious loss, while the British were to pay dearly for letting Kress von Kressenstein escape them. It is difficult to avoid the impression that the British were much too cautious in their counter-attack, even allowing for the fact that their reconnaissance capabilities were reduced by damage to the French seaplanes.

Djemal and Kress had twisted the lion's tail—and got away with it. There was little glory in the affair. But what there was must, on the Turkish side, go to those who crossed the Canal. Nearly 60 years before the SAMs and the Phantoms, the T62s and the Centurions, a few infantrymen struggled over the one hundred yards of the Canal, paddling rafts made of kerosene tins.

Anthony Burton

P38 LIGHTNING

An unorthodox US fighter with a great record and a few bad habits

US Air Force

Lockheed Lightning P38s flying wing-tip to wing-tip in the Pacific Theater of Operations during World War II. Such close-formation work demands vigilance from pilots formating on their leader, using the throttle only.

The Germans called it *'Der Gabelschwanz Teufel'*—'the 'Forked-tail Devil'. Americans who flew the Lockheed P38 Lightning knew it as the 'Angel'. Not every US Army pilot thought such a flattering nickname was justified.

But there can be no doubt that the Lightning was a very fine aircraft. Often it was mishandled or flown by inexperienced pilots, but its World War II combat record established its undeniable success as a warplane. The P38 flew in northern Europe, the Mediterranean, the Pacific, and in the China-Burma-India theater. It destroyed more Japanese aircraft than any other Allied fighter.

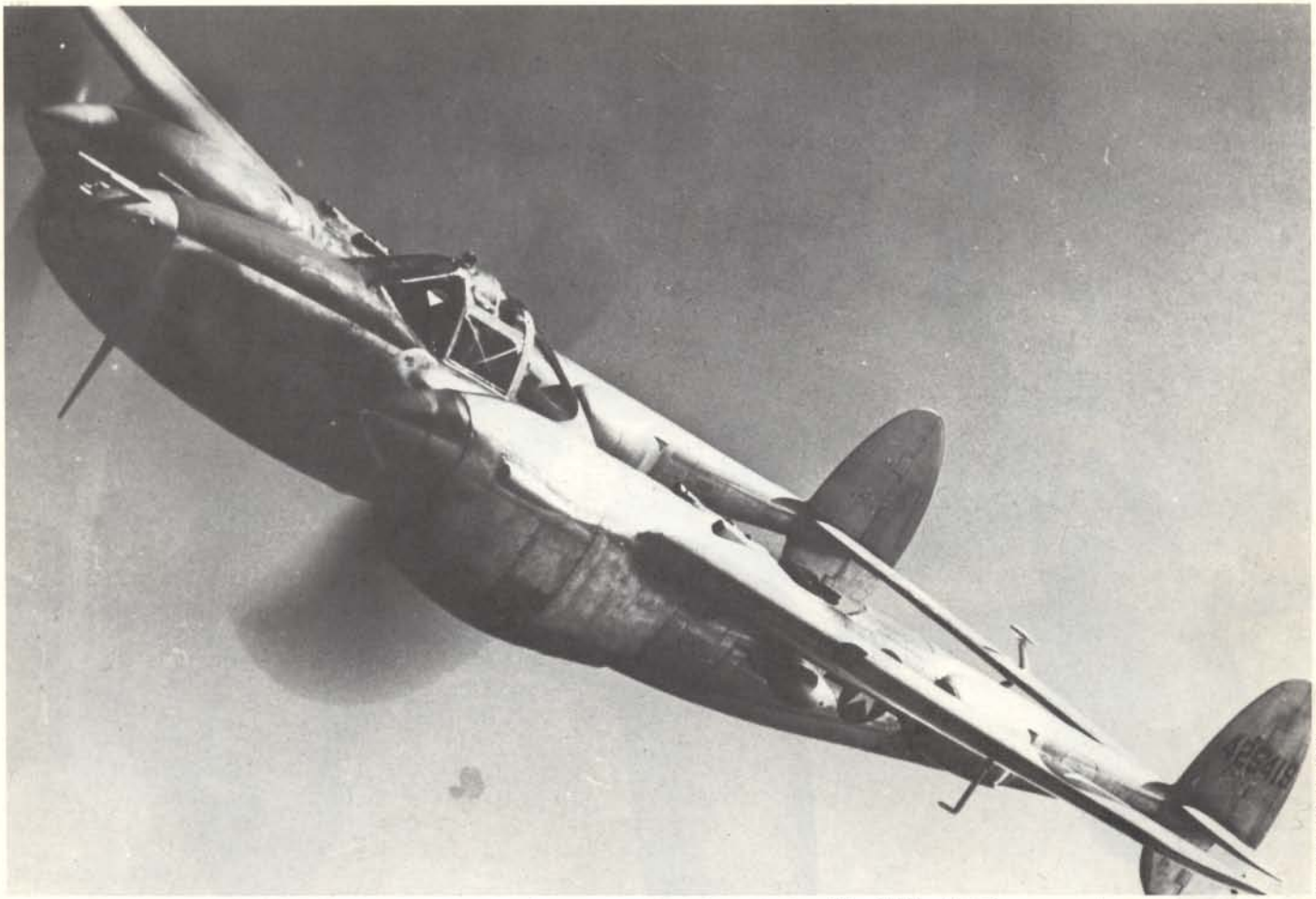
In 1937 the Lockheed company began designing an aircraft to meet the US Army's stringent specification for a new high-altitude interceptor. They concluded that to fulfil these requirements two engines would be necessary. The XP38 evolved as an unorthodox twin-boom machine with turbo-superchargers that cut in at 11,000ft. The pilot's cockpit was in a central nacelle which also accommodated a 23mm cannon and four .50 calibre machine-guns with an effective range of up to 1,000 yards.

At the beginning of 1939 the XP38 arrived at March Field, California. After an initial delay caused by brake failure during taxiing trials, the first flight was timed for January 27. Unfortunately when test pilot Ben F. Kesley tried to retract his flaps a control rod failed and it was only with the greatest difficulty that the wildly swinging XP38 was brought in for an emergency landing. Subsequent flights were uneventful, but to rekindle waning military interest a spectacular trans-continental flight was undertaken on 11 February. The plane took only 7 hours 2 minutes to reach Mitchell Field, New York, from California. This demonstration was marred, however, when Kesley throttled back too soon on his final approach to Mitchell Field and then flooded the engines by abruptly trying to open up again. He undershot and the XP38 ended up on its belly in a ravine.

The military were still impressed and placed an order for thirteen YP38s for evaluation, followed by contracts for nearly 700 production machines. But they insisted on almost 4,000 modifications. The 1,150hp Allison engines now drove outwardly rotating propellers—instead of the inwardly rotating airscrews of the XP38.

Not until June 1941 was the last of the YP38 series delivered, and when the Japanese attacked Pearl Harbor on 7 December there were still only 69 Lightnings with Army squadrons. Early production models were known as the P38D, the A, B and C designations having been given to experimental projects. As a result of the European combat reports self-sealing fuel tanks and armor plate were incorporated. Armament on the new models was a 37mm Oldsmobile cannon, two .5 MGs and two .3 MGs.

Initial enthusiasm for the sleek new fighter soon became tempered by doubts. During power dives pilots found that they were unable to pull out until they reached the denser air at low levels. Several P38s lost their tail units and the plane began to gain a bad name. The problem was simple—compressibility. P38 was one of the first airplanes to approach the speed of sound, and the only immediate remedy was to increase the effect of the elevator control.



Imperial War Museum

The cockpit cover of the P38 illustrates the state of canopy technology during World War II. The necessity to provide pressurisation and bullet-proof screens tended towards an angular rather ugly 'greenhouse' effect.

Early 1942 saw the appearance of the P38E, in which the additional ammunition capacity was provided and the cannon again changed to a 20mm Hispano. An unarmed photo-reconnaissance version of this model, known as the F4, was also produced and became the first of a whole series of camera-equipped Lightnings.

Before the end of 1942 the first of 525 P38Fs arrived, with 1,325hp engines and racks under the inner wings for two 1,000lb bombs or auxiliary fuel tanks. These were the earliest Lightnings to really achieve active service status, although an F4 based in Australia and piloted by Captain Karl Polifka had flown the P38's first operational sortie in June 1942—a reconnaissance over the Japanese fleet.

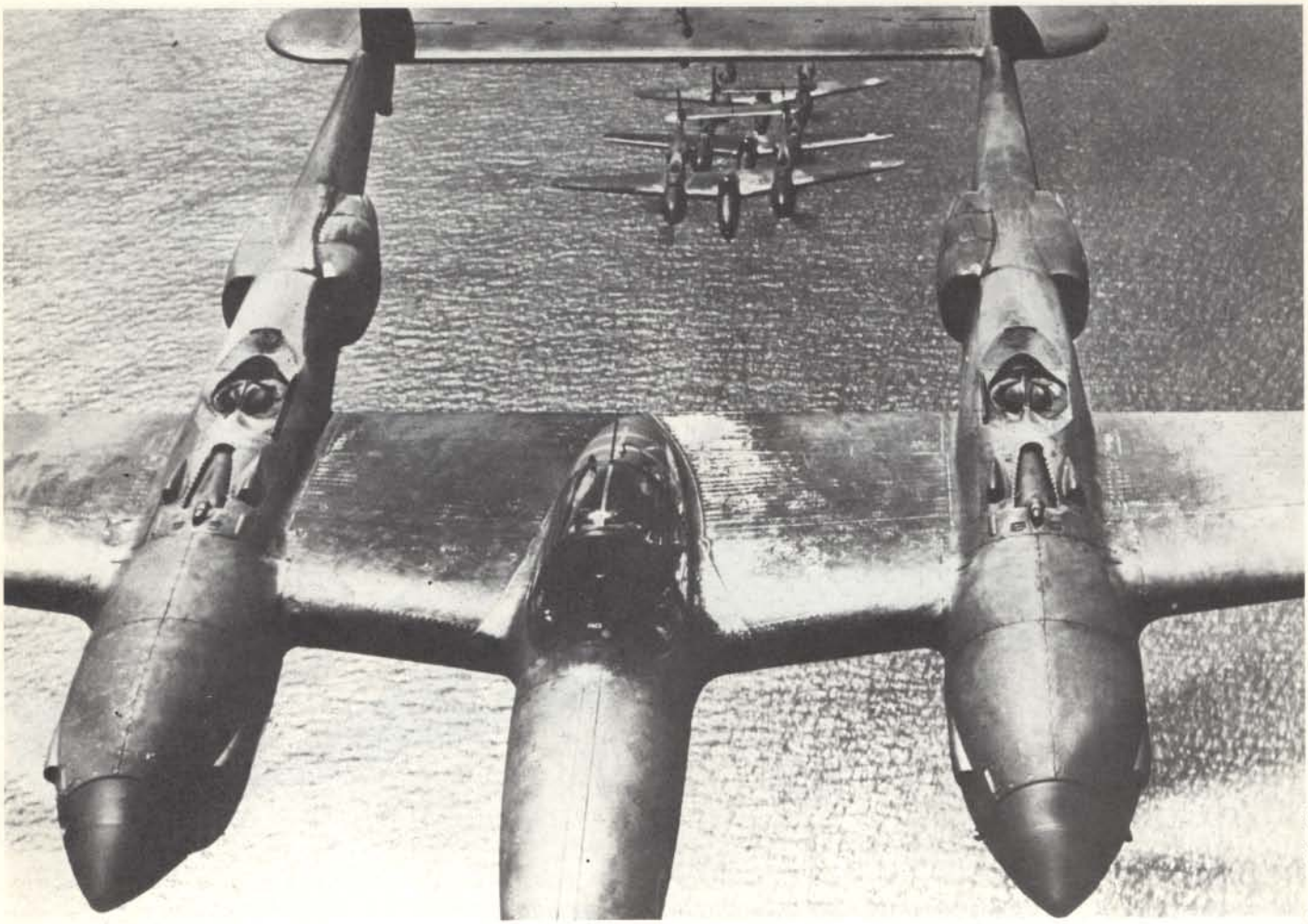
The Lightning made its debut as an interceptor in northern Europe in the summer of 1942. Two groups were ordered to England as part of the 8th Air Force. The 1st Fighter Group flew their planes over in July and August, followed by the 14th in October. This was the first time that fighter aircraft had used the hazardous North Atlantic ferry route.

One squadron from the 1st Fighter Group remained in Iceland to fly defensive patrols. During August a P38F of this unit piloted by Lieutenant Elza K. Shahan shot down a German Focke-Wulf Condor over the Atlantic to open the Lightning's combat account. The 1st and 14th Fighter Groups flew a number of missions over occupied Europe in the autumn of 1942, but in November they were transferred to the 12th Air Force in North Africa. Here, the P38 really began to see action on long-range escort duties, attacks against Axis shipping, and ground strafing.

It soon became apparent that the Lightning lacked the maneuverability of a single-engined fighter and was at a disadvantage in a dog-fight. Inevitably the P38 squadrons suffered substantial losses, but they scored a number of notable successes when sent to intercept enemy transport aircraft far out at sea.

From October 1942 onwards the Lightning was beginning to make its presence felt in the Pacific. Here, the vast expanses of ocean made the greater safety of two engines highly desirable. The first Pacific fighter groups to use the P38 were the 35th and the 49th. After some early technical difficulties the Lightning claimed its first successes against the Japanese in a spectacular manner on December 27, 1942. Twelve P38Fs shot down two bombers and nine fighters over Cape Endaiadere, New Guinea.

Against the nimble Japanese Zero the P38's poor maneuverability was again a serious handicap. American pilots soon learnt never to try to turn with a Japanese fighter. Instead, they patrolled at altitudes no Japanese fighter could reach and exploited their superior speed in attack. If a Zero did fasten itself to a Lightning's tail the American would go in a shallow full-throttle dive. At 350mph the P38 would be thrown into a 90° right turn which Japanese fighters were rarely able to follow as their controls stiffened at high speed. Sometimes, the Lightning's sensational climb would be enough to get a pilot out of trouble on its own. Also, once a P38 'jockey' lined up a Zero in his sights the concentrated fire power of Lockheed's



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powerful armament would shatter the inadequately protected Japanese plane.

The US 5th, 7th, 10th, 13th and 14th Air Forces all flew the P38 in the Far East and very soon the first Lightning aces began to achieve prominence. Lieutenant-Colonel Tommy Lynch set a brisk pace. By the autumn of 1943, when he went on leave, he had run up a tally of 16 victories to head the field. But already a young man named Richard Bong had opened his account by destroying five Japanese aircraft whilst flying a P38 with the 35th Fighter Group. He was now busy increasing his score with the 49th Group. Twenty-three-year-old Bong's only previous claim to fame was an audacious and gross breach of flying regulations when training on Lightnings in California. He was carpeted for looping a P38 round the center of the Golden Gate bridge and indulging in a low-level beat-up of San Francisco's fashionable downtown Market Street!

On 17 April, 1943, the Americans intercepted a signal that gave details of a planned visit by Admiral Isoroku Yamamoto —one of Japan's ablest military leaders—to Japanese bases on Bougainville, in the Solomons. His twin-engined Mitsubishi G4M, escorted by six Zeroes, was due at Kahili at 0945 on 18 April. The only available plane with both the range and the performance to intercept him was the P38.

The 339th Squadron on Guadalcanal was alerted, and four B24 Liberators were dispatched with enough jettisonable fuel tanks to provide 18 Lightnings with an extra 475 gallons each for the 1,100-mile round trip. Six P38s, led by Captain Thomas G. Lanphier, were to undertake the interception. The other 12 machines provided top cover.

Two members of the six-plane interception group aborted, but the 16 remaining Lightnings arrived at Kahili at 0935 to find a pair of G4M bombers coming in. They were easy prey. There were six Zeros escorting them—flying in two groups of three on either side.

Lanphier had only Lieutenant Rex T. Barber still with him. But with throttles wide open the two Americans turned in towards the Japanese formation. The Zeros banked over to meet the onslaught and a savage dog-fight began. In the milling confusion both Barber and Lanphier fired on a bomber. Lanphier saw the right wing fly off his burning target. It crashed into the jungle to explode in a burst of flame. Yamamoto died in that plane. Lanphier is generally held to be responsible for its destruction, although it had probably already sustained severe damage from Barber's attack a few seconds earlier. The other bomber was also destroyed along with several Zeros, before the P38s made for home. Only one Lightning was lost, but six of the 15 survivors were badly damaged.

The P38 laid the foundations to its impressive Pacific reputation in the fierce air fighting that raged over New Guinea during 1943. By September the Americans were able to mount a seaborne invasion of northern New Guinea. On 4 September the Lightnings of the 8th Fighter Group's 80th Squadron at Port Moresby were detailed to fly covering patrols over the beach-head area. Jay T. Robbins, then a 1st Lieutenant who had already scored a number of victories, shot down four Zeros in a single sortie. Then with no ammunition left, damaged controls and one engine failing he had to break off the engagement with three

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◁ *Menacing and every inch the pursuit fighter, P38.*
△△ *Wintry conditions for a groundcrew servicing a P38 reconnaissance plane. The cameras were installed in the nose section.*
△ *Close-up of a P38J. Note the 'spectacle'-type control wheel.*

Japanese fighters in hot pursuit. Robbins went low over the sea and led the enemy across some American cruisers and destroyers supporting the landing operations. AA fire from the ships finally drove off the Japanese planes and the crippled P38 was able to limp back to base. Robbins went on to become the fourth-ranking US ace in the Pacific and finished the war with 22 victories.

One of the men to fly the P38 was the famous long-distance airman, Colonel Charles A. Lindbergh. He went to the Pacific to demonstrate the Lightning's uses, and in the process shot down two Japanese planes.

A few P38s were fitted with a second seat behind the pilot for aircrew training purposes, but the controls were not duplicated.

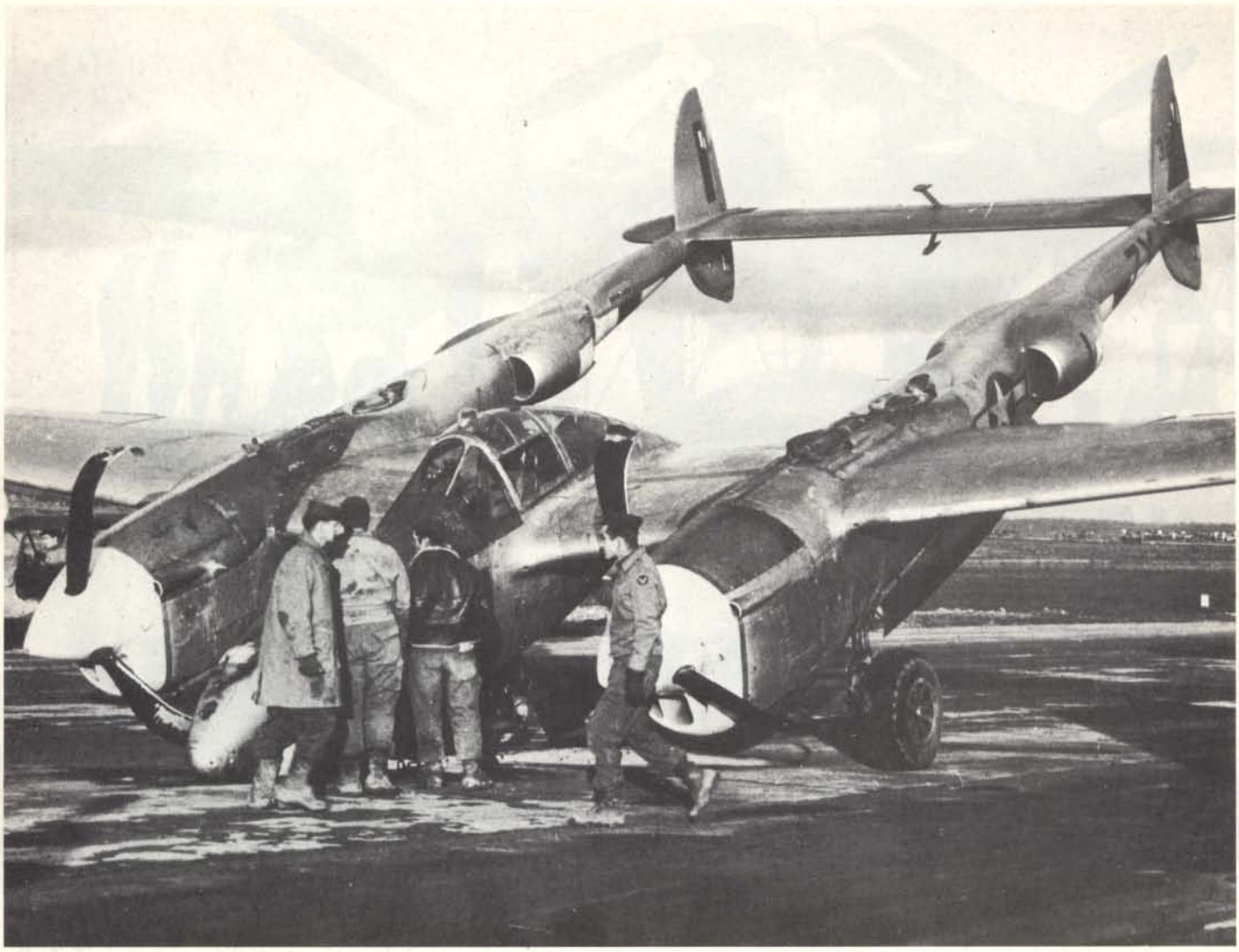
One of the main complaints about the P38 was of tail buffeting in high-speed dives. An experimental P38E was fitted with upswept booms to lift the tail clear of the airflow from the wings. But this crashed—killing test pilot Ralph Virden. Tail buffeting was eventually cured by slightly altering the angle of incidence of the entire tail assembly. A further refinement was achieved during the production run of the P38F series by incorporating 8° combat flaps that enabled much tighter turns to be made.

The Allison engines were also unreliable, particularly in North-West Europe where temperatures of minus 50°F are encountered at 30,000ft. The lubrication system frequently failed as oil became sluggish in the intense cold.

When the P38G appeared with 1,325hp Allisons it was necessary to restrict them to only 1,150hp above 27,000ft. The P38H was fitted with automatic oil-radiator flaps in an attempt to cure this. It had new turbo-superchargers coupled to engines of even greater power—1,425hp—but a 1,240hp limit was still necessary above 25,000ft. Bomb load was increased to 3,200lb.

The next variant—the P38J—started to reach combat units in August 1943. This incorporated some important innovations. Big chin-type air intakes were fitted. They accommodated radiators for the intercoolers—replacing the original system that cooled compressed air from the super-chargers by leading it up the inside of the wing before it reached the carburetors. Such an arrangement was vulnerable to battle damage and had also caused backfiring. The wing space was now free for extra fuel cells, which gave the P38 a ferry range of 2,260 miles and a flying time of 12 hours.

The bitterly cold cockpit of the Lightning was the subject of airmen's frequent criticism. On the P38J the heating system was considerably more efficient. And a bullet-proof panel was incorporated in the windshield. Combat maneuverability was improved by fitting a hydraulic aileron booster system that greatly enhanced the rate of roll. The circular control wheel that had been such a unique feature of the XP38 had gone. It was replaced by a spectacle-type column.



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For an interceptor fighter a conventional stick would undoubtedly have been better.

With its Allison engines at last cleared to develop their full power at high altitude, the P38J was the fastest of all operational Lightnings and attained a maximum level speed of 420mph. During oxygen tests a P38 reached 44,940ft, and in March 1944 Ben Kesley clocked an indicated 750mph during a power dive—although the instrument error above 550mph gave a greatly exaggerated reading. An attempt to repeat this dive two months later resulted in the wings folding at 23,000ft and Kesley had to bail out.

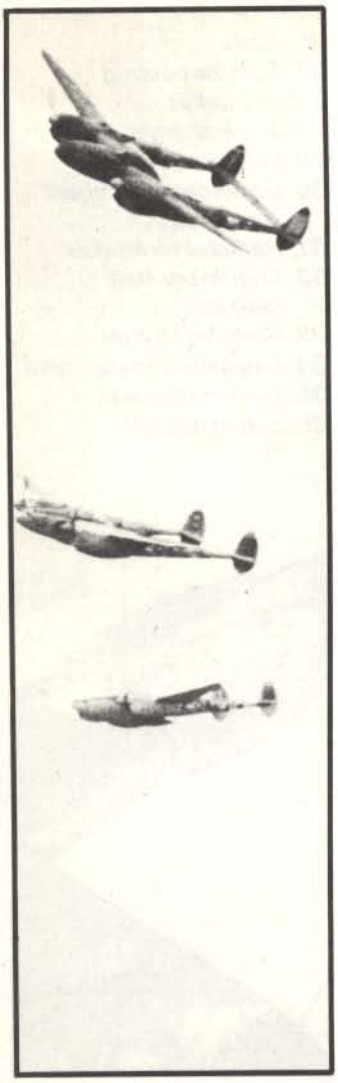
Performances like this brought renewed high-speed handling problems. Electrically operated dive flaps were fitted beneath each wing to counter a nose-down pitching moment. Wing instability also began to appear, and careful filleting at the junction between the wing and the fuselage was necessary to smooth out the airflow.

It became clear early in 1942 that daylight bombing missions over Europe needed fighter escort. The P38 was the only Allied plane with range enough to do the job. Unfortunately the Lightning could not really handle the formidable German fighters at the altitudes where the bombers flew. Continual engine trouble caused more losses than the *Luftwaffe*, and the Germans soon discovered that the big Lockheed had a poor rate of roll at height. It could be easily out-maneuvered if caught above 25,000ft. But at lower altitudes the P38 was a match for the Messerschmitt Bf109G and could hold its own against the Focke-Wulf FW190A.

On 3 March 1944, 8th Air Force P38s were the first AAF combat planes to appear over Berlin. On 29 July 1944, a P38 was the first Allied plane to tangle with the new German reaction-propelled aircraft. But the Lightning's days as an interceptor in northern Europe were numbered. With the Allied invasion pending, however, photo-reconnaissance became important and the P38 proved the ideal machine for the job. Small numbers of each Lightning variant since the E-model had been modified to carry cameras, and photo-reconnaissance P38s performed invaluable work before the Allied invasion of Italy in September 1943. They flew over 300 sorties. A specially prepared Lightning with its super-chargers removed, ultra-powerful engines, and a high-speed wax finish took low-level photographs of the Normandy coastal defenses as part of the preparations for D-day. The Lightning was also a useful ground attack fighter and could withstand considerable battle damage—although the liquid-cooled Allison engines were vulnerable to ground fire.

With the 12th and 15th Air Forces over southern Europe the P38 continued to serve as an escort fighter until the end of the war, but losses were sometimes heavy. When the Allies invaded southern France in August 1944, the 1st and 14th Fighter Groups lost 23 Lightnings in one day.

In its fighter-bomber role the P38 could now carry two 2,000lb bombs and was sometimes used for medium



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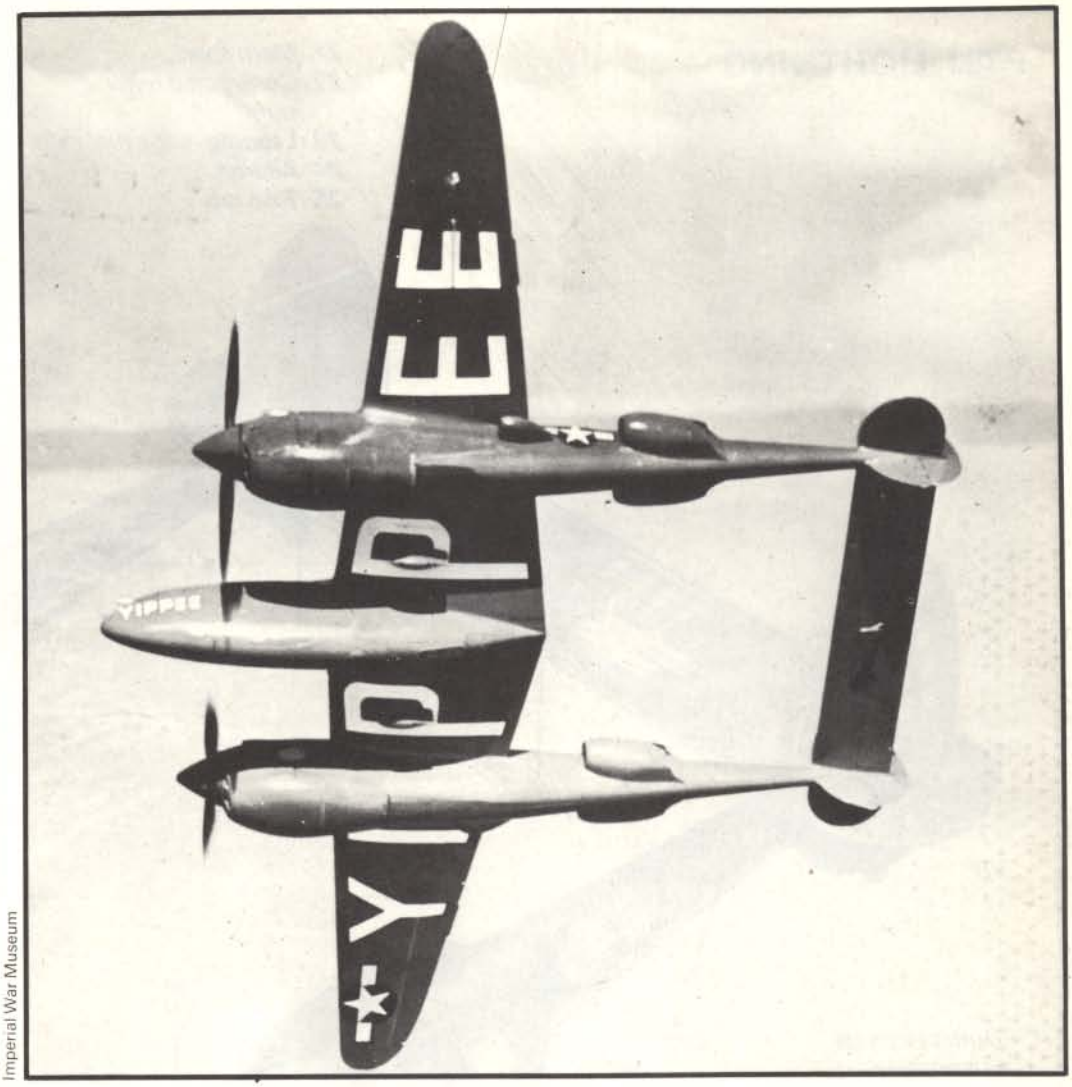


Imperial War Museum

◁ *The results of a nose-wheel failure on landing. This lightning is a P38 of the 428th Fighter Squadron, 474th Fighter Group, 9th AAF. A jeep airfield crash unit hovers in the background.*
△ *Four P38s from the 9th USAF peel off for their landing on a French airfield after a mission.*
△▷ *'Yippee!' The 5,000th P38 to roll off the assembly lines on the Pacific coast. The plant was awarded the US Army and Navy efficiency medal for production achievements.*

altitude raids. 'Pathfinder' Lightnings were adapted to lead these strikes and became known as 'droop snoots' because they had a lengthened nose containing a Norden bomb sight and a bombardier's position. A radar bomb sight was fitted later. The pathfinder aircraft would head up the formation and find the target. The other planes took their cue to unload from the 'droop snoot' lead ship.

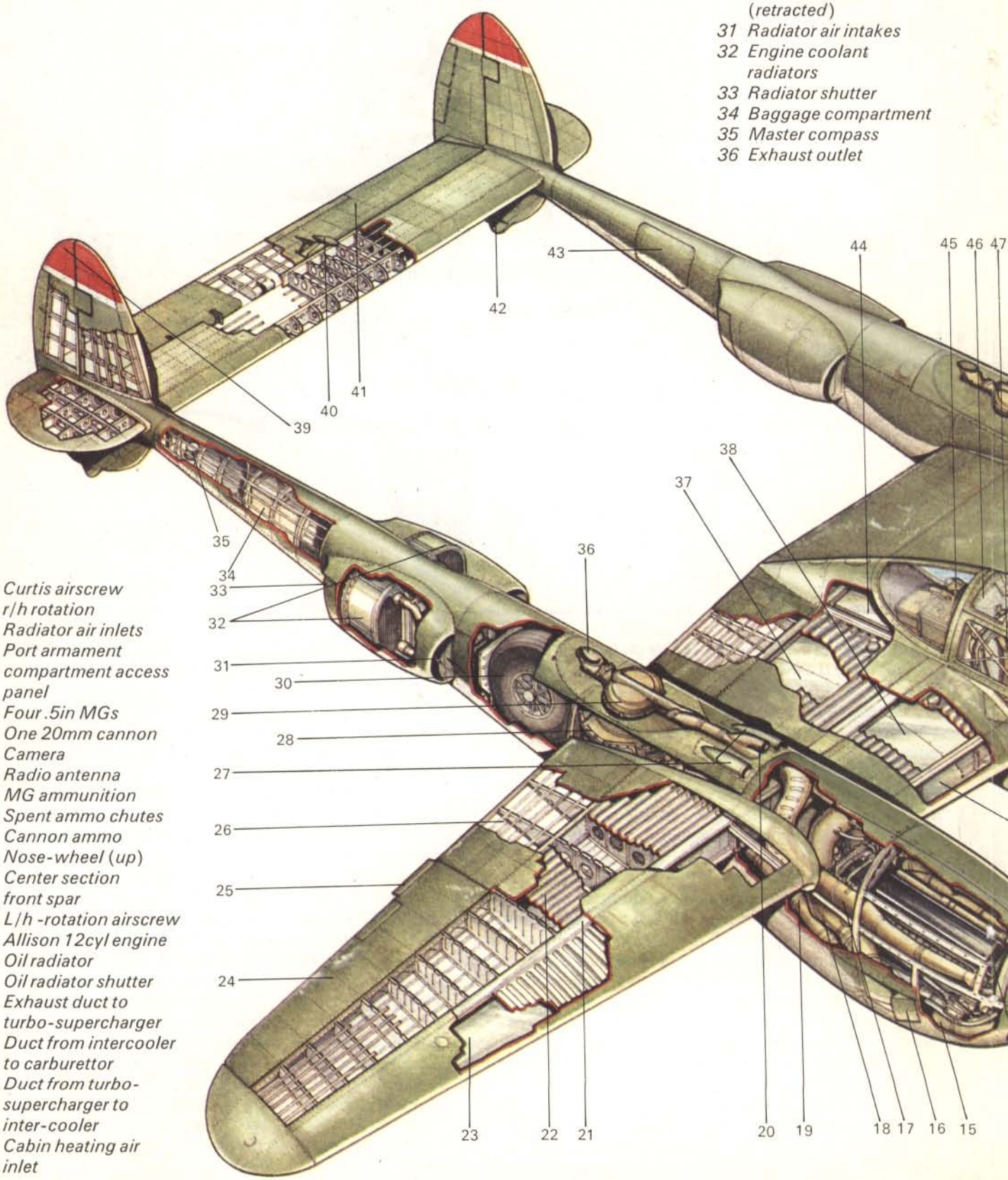
The first of the top Lightning aces, Tommy Lynch, returned to the Far East early in 1944 to find that Richard Bong had shot down 21 Japanese aircraft. Another P38 pilot, Tommy McGuire, was not far behind with 11 kills. Lynch and Bong frequently flew together and on 9 March 1944—with Bong's tally now 24 to Lynch's 20—the two went down to strafe a corvette escorting two luggers towards Hollandia. The Japanese AA gunners sent up a fierce barrage. Suddenly Lynch broke away with an engine smoking to head back for the shore. He never made it. A propeller flew off and Lynch bailed out, but before he was clear, the P38 blew up—killing him instantly.

On 12 December 1944 Bong received the Congressional Medal of Honor and a few days later he was taken off operations. His final score of 40 victories made him the all-time number one US fighter ace. He met his death on 6 August 1945, when the Lockheed P80 jet fighter he was testing flamed-out on take off at Los Angeles.

On Christmas Day, 1944 Tommy McGuire—Bong's nearest rival—knocked down four to bring his tally to 38. He did not fly in action again until January 7, when he led four P38s in a bounce on a lone black-painted Zero above Negos Island. The Japanese airman hurled his plane round in a steep left turn and fired on the tail of one of the Lightnings. Its pilot, Major Rittmayer, called for help. MacGuire went to his aid and in doing so broke three of his own vital rules for air fighting. He got involved in a dog-fight at low altitude with his air speed below 300mph and his drop tanks un-jettisoned. His enemy whipped into a hard right turn to come down on McGuire's tail. Only 200ft up and a bare 180mph on the clock, McGuire pulled a fiercely steep bank but with the bulky wing tanks still in place the P38 failed to make it. The Zero's fire lashed into the Lightning. which stalled and exploded on the ground. Tommy McGuire was dead.

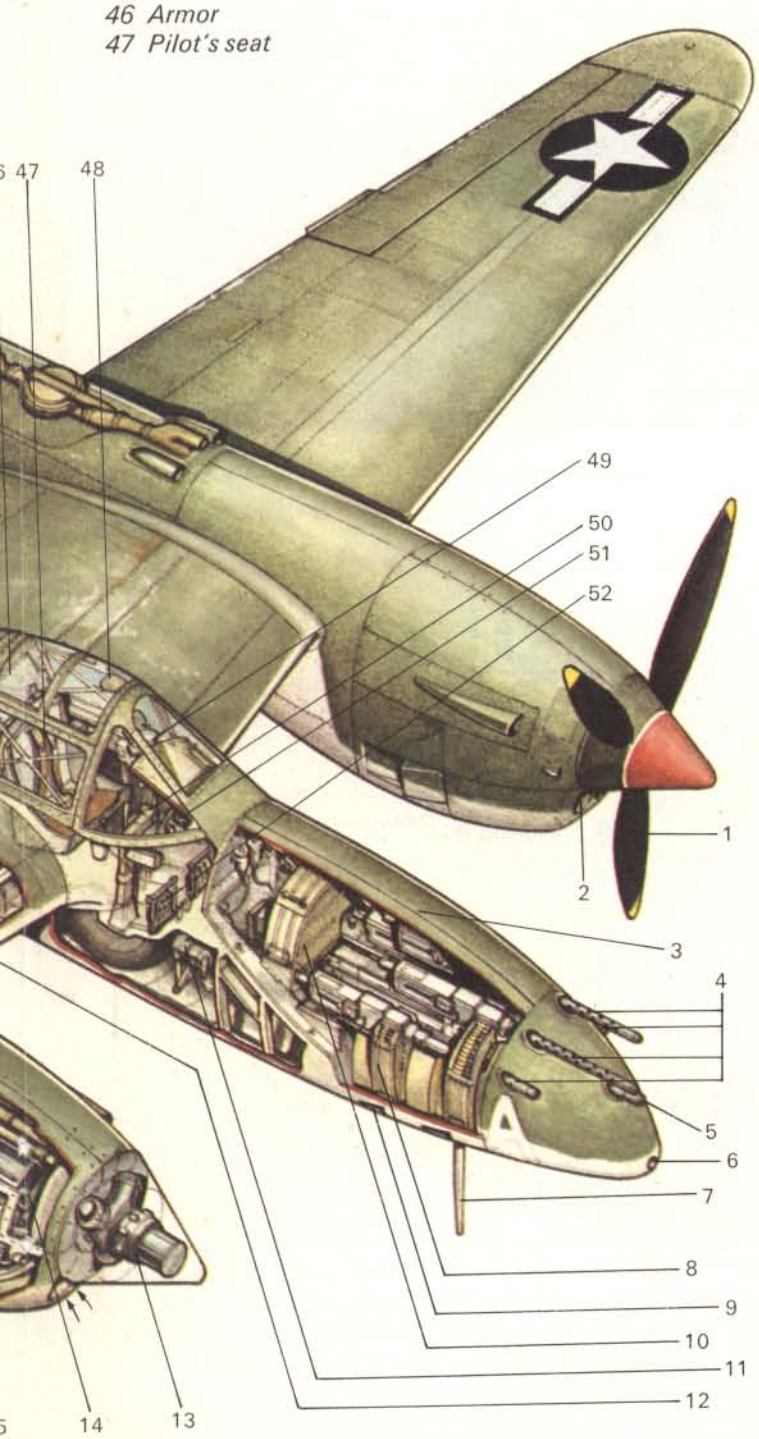
The last version of the Lightning to achieve major produc-

P38J LIGHTNING



1 Curtis airscrew r/h rotation
2 Radiator air inlets
3 Port armament compartment access panel
4 Four .5in MGs
5 One 20mm cannon
6 Camera
7 Radio antenna
8 MG ammunition
9 Spent ammo chutes
10 Cannon ammo
11 Nose-wheel (up)
12 Center section front spar
13 L/h -rotation airscrew
14 Allison 12cyl engine
15 Oil radiator
16 Oil radiator shutter
17 Exhaust duct to turbo-supercharger
18 Duct from intercooler to carburettor
19 Duct from turbo-supercharger to inter-cooler
20 Cabin heating air inlet
21 Main spar
22 Corrugated inner skin
23 Leading-edge fuel cells
24 Aileron
25 Trim tab
26 Flaps
27 Turbine cooling air intakes
28 Supercharger
29 Exhaust turbine
30 Undercarriage wheel (retracted)
31 Radiator air intakes
32 Engine coolant radiators
33 Radiator shutter
34 Baggage compartment
35 Master compass
36 Exhaust outlet

37 *Starboard fuel cell*
38 *Starboard reserve fuel cell*
39 *Starboard rudder*
40 *Elevator mass balance (upper)*
41 *Elevator*
42 *Tail skid*
43 *Battery compartment*
44 *Fuel surge tank*
45 *Radio equipment*
46 *Armor*
47 *Pilot's seat*
48 *Rear-view mirror*
49 *Reflector sight*
50 *Control column*
51 *Instrument panel*
52 *Rudder pedals*



tion status was the P38L. Nearly 4,000 were built. This model differed little from the P38J but had engines with a higher wartime emergency rating of 1,600hp at 26,500ft.

On the western front, however, the P38 was approaching the end of its career. The 8th Air Force began replacing its Lightnings with P51s in the summer of 1944. None remained by the beginning of 1945. The 9th Air Force retained only one of its three P38 groups until the cessation of hostilities.

In the Pacific, where the Japanese never developed an effective high-altitude fighter, the P38 played a crucial role right up to the Japanese surrender. After Bong's return to the United States and McGuire's death, the two top Lightning pilots were Gerald R. ('Jerry') Johnson and Charles H. MacDonald. Johnson commanded the crack 49th Group and had 22 Rising Sun flags painted on the nose of his P38 at the end of the war. He was killed in Japan on 7 October, 1945, in a flying accident.

The stern-faced MacDonald shot down 27 Japs in air combat and was third-ranking US ace in the Pacific—5th in all theaters. Probably, MacDonald's most memorable day in combat was 7 December 1944. He flew four missions over the American invasion force landing at Ormoc Bay, northwest Leyte, and brought down three Japanese fighters. MacDonald survived the war to embark on a peacetime Air Force career.

First Allied craft to land in Japan

The final variant of the Lightning was the P38M, a two-seat night-fighter version of the P38L. It was equipped with radar and saw action in small numbers against the Japanese during the final months of the war. To bring the Lightning's combat career to a fitting conclusion, two P38s were the first Allied aircraft to land in Japan after the surrender. Colonel Clay Tice and his wingman landed at Nittagahara on 25 August after claiming to have suffered suspiciously opportune 'engine trouble'.

The weight-lifting capabilities of the P38 were put to a number of unorthodox uses—modified drop tanks being devized to fly maintenance men into advanced airstrips in an emergency or to evacuate casualties. One nerveless photographer—Lieutenant D. D. Duncan—rode in a specially fitted-out tank under a Lightning to film Marine Corps Corsairs attacking Japanese positions on Okinawa. P38s also served as glider tugs, and were equipped to carry rocket projectiles, incendiary bombs and smoke canisters.

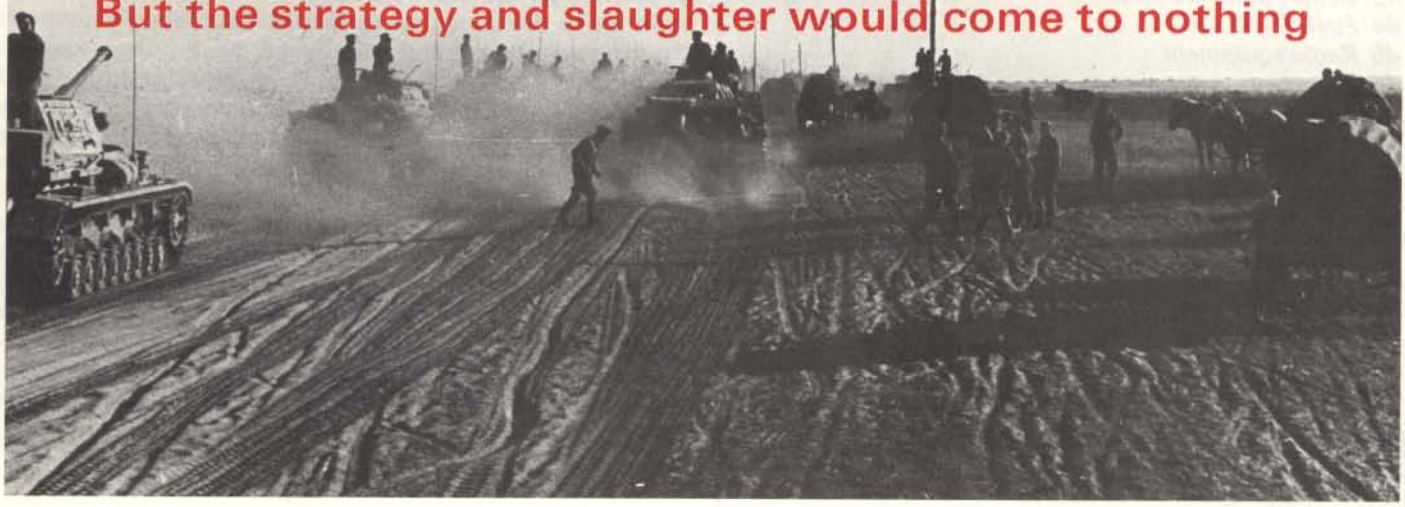
The P38 was a complex airplane. It was never intended for mass production—the cost of a Lightning in 1944 being $97,147, compared with only $51,572 for a P51. A total of 9,923 were built—not a big production run for a fighter that saw extensive service for nearly four years. Very few air forces other than that of the United States flew the type. A number were evaluated by the RAF early in 1942 but these P322 Lightning Is lacked turbo-superchargers and had early-type Allison engines fitted with right-hand propellers. Not surprisingly the performance was totally inadequate. The 143 models built ended up as trainers or experimental aircraft in the United States. The Lightning II was basically a P38G intended for RAF use, but the 524 ordered were diverted to the USAAF. None reached Britain.

Some Lightnings saw service in the Free French Air Force, and the Chinese Nationalist Air Force. The Honduran Air Force and the Italian Air Force also flew the P38.

Rodney Steel

KIEV 1941

Germany's greatest victory; Russia's worst defeat. But the strategy and slaughter would come to nothing



Suddeutscher Verlag

Hitler hailed it as 'the greatest battle in the history of the world'. For on 16 September 1941 the German *Panzergruppen* of Colonel-Generals Heinz Guderian and Ewald von Kleist had joined hands in the Ukraine at Lokhvitsa, 125 miles east of Kiev. The Soviet commander in the Ukraine, Marshal Semyon Mikhailovich Budenny, had just been sacked by Stalin, but his army group was encircled. Within 10 days the Germans captured 665,000 prisoners, 884 tanks, 3,718 guns and 3,500 motor vehicles. Colonel General Franz Halder, Chief of the German General Staff, called Kiev the principal strategic blunder of the Russian campaign. His view seems irreconcilable with Hitler's. How had it all come about?

The answer lies in the planning and aims of Hitler's invasion of Russia. As early as 1924, Hitler's book 'Mein Kampf' was explicit: 'We stop the endless German movement to the south and west, and turn our gaze towards the land of the East. If we speak of new territory in Europe today, we can primarily have in mind only Russia and her vassal border states . . . . This colossal empire in the East is ripe for dissolution.' Hitler's foreign policy was not just to abolish the Treaty of Versailles and extend the *Reich's* frontiers to include all Germans. These aims were virtually achieved by 1939 without recourse to war. But *Lebensraum* ('living space') demanded far more than what was 'rightly' Germany's. It needed Russia for ideological as well as strategic reasons.

Despite all the campaigns in the west and the south, it can be argued that Hitler concentrated three-quarters of his forces with his prime object clearly in view—the defeat of Russia. Only then could he settle 100 million Germans of pure Aryan stock on lands east of Germany to ensure that the New Order would last for a thousand years.

Hitler knew that the establishment of a German empire in the East, would, sooner or later, mean war with Russia. Even in 1934 he was telling Hermann Rauschning: 'We

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△△ *German armor passes locally commandeered* panje *carts on a typical Ukranian dust track. The two* Panzergruppen *which netted 665,000 Russians began the battle with only 36 per cent of tank fighting strength. Their 11* Panzer *divisions mustered 1,100 tanks at best.*
▷ *A wary German covers a burning village with his 9mm Machine-pistol Model 1940 (MP40), the 'Schmeisser'.*
△ *Operation* Barbarossa, *most ambitious invasion of all time, was planned to take four months. It lasted four years.*

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cannot in any way evade the final battle between German race ideals and pan-Slav mass ideals. Here yawns the eternal abyss which no political interest can bridge . . . . We alone can conquer the great continental space, and it will be done by us singly and alone.'

It might be necessary to make arrangements with the Soviet Union along the way, but only the more quickly to erase Russia completely for 'it will open to us the mastery of the world'. In July 1940, with France crushed but England defiant, Hitler turned his arguments inside out when trying to persuade his Commanders-in-Chief about how to defeat England. England's hope, lay in Russia and the United States. If Russia dropped out of the picture, America would too, for Russia's elimination would make America think only of Japan's threat to themselves. 'Decision: Russia's destruction must therefore be made part of this struggle. The sooner Russia is crushed the better. The attack will achieve its purpose only if the Russian state can be shattered to its roots with one blow . . . if we start in May 1941, we will have five months in which to finish the job.'

In December 1940 Hitler's War Directive No 21, *Case Barbarossa*, sent a shiver down the spines of those first privileged to read it. 'The German Armed Forces must be prepared, even before the conclusion of the war against England, to crush Soviet Russia in a rapid campaign.' The bulk of the Red Army stationed in Western Russia would be encircled and destroyed by deeply penetrating armored forces. Above all, any Soviet forces still able to fight would be prevented from withdrawing into the depths of Russia. Herein lay the reason for the battle of Kiev. Hitler's directive gave a broad outline of the conduct of operations and the final objective—the creation of a barrier against Asiatic Russia on the general line of the Caspian Sea at Astrakhan to Archangel in the Arctic. It did not say how and where the Soviet armies were to be destroyed. This failure to draw up an absolutely clear and realizable master plan for the Red Army's annihilation ensured that the astonishingly successful Kiev battles made no difference to the final outcome of the war.

Hitler had always maintained that 'we have only to kick the door in and the whole rotten structure will come crashing down'. In order to foment this instant collapse three Army Groups were assembled. Army Group North would strike for Leningrad. Army Group Centre with the two main *Panzergruppen* (1,770 tanks) was aimed at Smolensk. Field Marshal Karl Gerd von Rundstedt's Army Group South was to deal with the enemy west of the Dnieper river in the Ukraine. Throughout planning, Hitler constantly reiterated the need to wipe out, not just put to flight, the main enemy forces. But he consistently failed to lay down any absolute strategic plan or objective to which all operations would contribute and be subordinate.

As *Barbarossa* developed, the Fuehrer constantly chopped and changed, or worse still, vacillated. In spite of rapid advances and huge bags of prisoners, there was little sign of the whole Soviet structure crashing down. Army Group North got to Leningrad, but was repulsed before the city itself and had to be content with investing it (see 'War Monthly': Issue 2). Field Marshal Fedor von Bock's Army Group Centre executed a great pincer movement converging on Minsk and by 10 July, 20 days after the start of the campaign, claimed 300,000 prisoners. The battles around Smolensk started a week later and lasted for three more They produced a comparable number of prisoners, but took such a toll of von Bock's armies that the advance towards Moscow from Smolensk was not resumed *until 2 October*. It was this lack of a conclusive decision in the north and center, combined with Hitler's constant change of heart over what constituted decisive objectives, which led to glittering but illusory success in the Ukraine.

On 19 July Hitler issued his War Directive No 33. This directive (and its supplement on the 23rd) caused furious

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◁ *This 37mm flak gun destroyed 23 Soviet planes and took a field-kitchen on an airfield by the river Sluch about 150 miles NW of Kiev, July 1941. The burning fighters are* left *a Polikarpov I-16* Rata *and* right *its 1934 I-15 biplane contemporary. The Red Air Force had lost 14,000 aircraft by September and the* Luftwaffe *enjoyed total air superiority.*
△ *A German MG34 being used off its tripod from the citadel of Kiev which fell, with 30,000 POWs, on 20 September to the Sixth Army, destined itself for entombment at Stalingrad a year later.*
▷ *Four well-camouflaged 75mm assault-guns pass an infantry 81mm mortar team. On the right is an* Obergefreiter, *their NCO, a corporal with fewer than six years' service.*

controversy between the Feuhrer and his generals. In the first place Army Group Centre was instructed to keep advancing on Moscow. while its vital *Panzer* formations were hived off. *Panzergruppe 3* was to join in the battle for Leningrad. Guderian's *Panzergruppe 2* would attack the Ukraine in conjunction with von Kleist's *Panzergruppe 1* from Army Group South. Hitler made it clear that the priorities were the capture of Leningrad whose fall, he believed, would lead to the collapse of the regime it politically symbolized, and the Ukraine, an economic objective to be denied to Russia and used by Germany.

Col. Gen. Halder, Chief of the General Staff, argued that the whole campaign was endangered by the lack of a clear aim. Were the Fuehrer's aims military conquest or economic exploitation? Hitler replied that both were equally important. But when Halder supported by von Bock, von Rundstedt, Field Marshal Walther von Brauchitsch (C-in-C of the Army) and Guderian insisted that a final autumn thrust must be made on Moscow, Hitler simply lectured his Commanders on the economic aspects of conducting war. Hitler only conceded Army Group Centre a defensive role after losing its *Panzergruppen.* It would not have to push on to Moscow with infantry alone. A 12 August supplement to Directive No 34 made it plain that the new offensives would be directed north on Leningrad and southwards to the Crimea, Kharkov, the Donets river basin and the Caucasus mountains. Large enemy forces on the flanks of Army Group Centre, especially the Soviet Fifth Army in the Pripet Marshes north of Kiev, were to be destroyed. This was the foundation of the great Kiev battles.

Among those who attempted to dissuade Hitler was the very man who did most to make the Kiev battles a stupendous triumph. In a last-ditch attempt to overturn the decision, Guderian obtained an interview with Hitler in the *Wolfsschanze* ('Wolf's lair' HQ at Rastenburg in E. Prussia) on 23 August. He pointed out that Moscow was the objective which ordinary soldiers understood. It was also a vital communication center, the political 'solar plexus' of the Soviet Union, industrially important and psychologically perhaps conclusively so. He maintained that to capture Moscow first and destroy the Russian forces defending it (half-a-million men had escaped from the Smolensk encirclement) would make the subsequent overrunning of the Ukraine easy. To go for the Ukraine first would rob the *Wehrmacht* of the chance to take Moscow before winter came.

Guderian heard what was planned for his own *Panzergruppe*—movement to the Ukraine and back involving more than 600 miles—he commented, 'I doubt if the machines will stand it, even if we are unopposed'. But having been told by Hitler that Moscow must wait and the Ukraine offensive go ahead, Guderian assured the Fuehrer that he

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would do his best. Hitler used Guderian's acquiescence to parry the continued doubts of Halder. He was always dividing and ruling his servants. But whatever the decision-making process, the outcome was that the main striking power of the German Army went north and south, not east to Moscow.

If there was discord among German military leadership about where to continue the offensive, there was just as much discord in STAVKA, the Soviet High Command, about how to stem its seemingly invincible advance. Colonel General M. P. Kirponos's SW Front had been pushed back into the Ukraine, while Hitler's Rumanian satellite armies from the Balkans begun to move into Bessarabia and towards Odessa. The Soviet problem here was the unenviable one of trying to defend a broadening front with disintegrating forces. STAVKA decided to amalgamate Southern and SW Fronts into one SW Theater. Stalin appointed as its Commander his old crony, Marshal Budenny. The Commissar with a main job of evacuating industry was none other than the 47-year-old Lieutenant General Nikita S. Khruschev. The 58-year-old Budenny, having held no real field command for 20 years, had little to recommend him save political 'reliability' against the German professionals, von Rundstedt and von Kleist.

As if choosing so questionable a commander was not enough, Russian strategy itself was soon a matter of violent disagreement. At a meeting in Moscow on 29 July General Georgi K. Zhukov, Chief of the General Staff, urged that Kirponos's SW Front be withdrawn from the Dnieper river-line, even though this meant giving up Kiev. Stalin angrily rejected such a course, and instantly accepted Zhukov's offer to resign. Zhukov therefore went off to command the Reserve Front. The ailing Marshal Boris M. Shaposhnikov became Chief of the General Staff again. In any event, Stalin's decision to fight on the line of the Dnieper prevailed. Kiev, capital of the second most important Socialist Republic, was to be held at all costs.

Marshal Budenny's army group was positioned in an enormous salient about 150 miles wide, stretching from Trubchevsk in the north to Kremenchug in the south with Kiev as the apex of the salient sticking out to the west. The opportunity for encirclement and annihilation was therefore present from the outset. Budenny had the best part of a million-and-a-half soldiers in his area, about eight armies mainly at Uman and Kiev itself.

The German recipe for annihilation was *double* encirclement. The first and *inner* ring would be drawn by three infantry armies; the Second moving SE from Gomel, the Seventeenth striking north from Kremenchug and the Sixth keeping Russian attention riveted on Kiev itself. Meanwhile the *outer* ring would be closed by Guderian's *Panzergruppe* driving south with some 500 tanks from Trubchevsk to meet von Kleist's 600 tanks striking north from Kremenchug, at a point some 125 miles east of Kiev. It was the strategist's dream, a recreation of the unique victory won by Hannibal over Rome at Cannae in 216 B.C. The Carthaginian military genius had destroyed 70,000 out of 86,000 Romans for a cost of only 5,700. His infantry had lured eight legions into the heart of their concave formation while the cavalry smashed the Roman wings and enveloped the infantry—to charge into their rear.

While the German plan unfolded, the Russians seemed to be paralysed and incapable of decisive action. Had Budenny had any inkling of the scope of German plans, he might have reversed his troop concentrations to withdraw behind the Dnieper. But having no motion of the kind of

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◁ *An MG34 covers armor emerging from a Ukranian wood. The belt feeder has a mechanic's sleeve badge.*
▷ Nachrichtentruppe (*signallers*) *with* panje *carts move into Kiev which remained German until 6 November 1943.*
▷▽ *This* Panzer-*type* (*III or IV*) *composed 75% of the 3,200 tanks with which Hitler invaded Russia.*

battle about to be fought, he reinforced those very areas, like Uman, which were to be engulfed even before the main battle was launched. While Uman was being reinforced, von Kleist's three *Panzer* Corps were dashing eastwards roughly between the two main Soviet concentrations at Uman and Kiev. By the end of July the *Panzers* were more than 100 miles SE of Budenny's main forces. The noose east of Uman was looped by Eleventh Army infantry crossing the river Bug and pushing on to Novo Ukraine where they joined up with 14 *Panzer* Corps from the north. Uman was a foretaste of greater things to come—by 8 August 103,000 prisoners had been taken from 21 divisions of three encircled Russian armies. The week's reduction of the pocket yielded booty totalling 850 field guns, 317 tanks, and 242 AT and AA guns. One German artillery battery pounding these targets fired more ammunition in four days than it had in the entire six-week 1940 campaign in France.

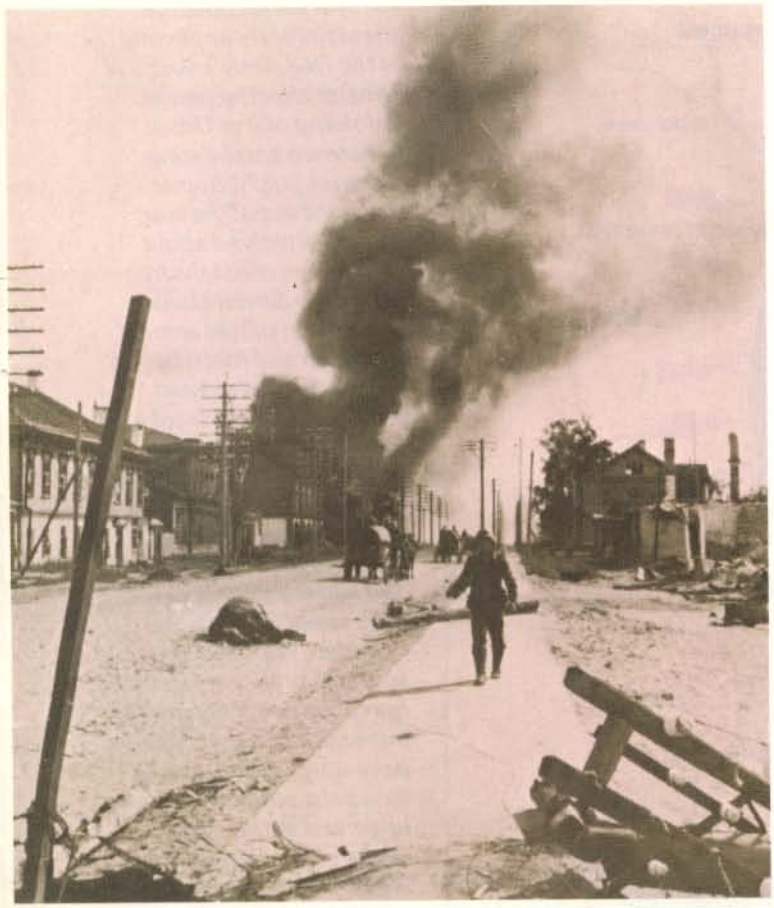
At this point in the Russian campaign—it was still only August—seven weeks after the start, the morale of the *Wehrmacht* was at its peak despite checks at Leningrad. In the south they were advancing fast without too much opposition. When the Russians did counter-attack, they usually signalled its coming by a lot of radio conversation *en clair* and then stuck to their normal pattern of a short artillery bombardment followed by wave after wave of infantry. Sometimes they were supported by tanks or trucks crammed with soldiers which simply drove straight at the German positions until inevitably knocked out. These were halcyon days and it was as well that the Germans enjoyed them for there would not be much more to enjoy after the autumn. This gallop across the Ukraine was recalled by C. Malaparte: 'During the night-time all fighting ceases. Men, animals, weapons rest. Not a rifle shot breaks the damp nocturnal silence. Even the voice of the cannon is hushed. As soon as the sun has set, and the first shadows of evening creep across the corn field, the German columns prepare for their night's halt. Night falls, cold and heavy, on the men curled up in the ditches, in the small slit trenches which they have hastily dug amid the corn, alongside the light and medium assault batteries, the anti-tank cannon, the heavy anti-aircraft machine guns, the mortars . . . . Shielded from sudden attack by the sentries and patrols the men abandon themselves in sleep. There in front of us, concealed amid the corn and with the solid dense mass of the woods—over there beyond the deep, smooth, bleak fold of the valley, the enemy sleeps. We can hear his hoarse breathing. We can discern his smell—a smell of oil, petrol and sweat.'

By 7 September German operations were crystallizing. During a visit to von Rundstedt's Army Group South HQ, Halder agreed final details of the plan involving both this army group and Army Group Centre by which all enemy in the Kiev-Dnieper-Desna bend would be destroyed and Kiev itself taken. From Army Group Centre, Guderian would continue his 12-day-old thrust southwards from Starodub to Romny and Priluki with Second Army covering the right flank of the *Panzer* advance. From Army Group South, Seventeenth Army would pin the Soviet forces on the Lower Dnieper below Cherkassy and get a bridgehead over the river at Kremenchug. Then von Kleist could drive northwards from it to link up with Guderian in the general area Romny-Lokhvitsa thus cutting off some six Soviet armies. Field Marshal Walther von Reichenau's Sixth Army would cross the 700-yard wide Dnieper opposite Kiev and attack the encircled Soviet forces there.

Within a few days the German armies had made great strides. Seventeenth Army crossed the Dnieper on 11 September and von Kleist was packing his tanks into the bridgehead. To counter these moves, Budenny's only recourse was a desperate appeal to Stalin on 11 September for permission to withdraw.

It is possible, when we remember that he had given Budenny over a million men, to sympathize even with Stalin's exasperation and his refusal to authorize retreat to the east. Instead the Party slogan was 'Stand fast, hold out, and if need be die'. But by this time it was virtually too late. From the outset Russian leaders just could not believe that Hitler would abandon Moscow as his prior target when it looked as if he could reach it even earlier in the year than Napoleon (14 September 1812)—so while Guderian was seen to be heading south, it was thought that he was only trying to dodge round the strong Soviet forces barring the direct route to Moscow. Russian mobility, despite mechanization tied essentially to the foot soldier, could never hope to match that of the German *Panzer* troops who roamed more or less at will, at least six times as fast.

What is more after von Kleist's breakthrough, there was nothing to stop them. Indeed with his *Panzers* ranging as far east and south as Dnepropetrovsk, Krivoi Rog and Nikolayev, von Rundstedt's difficulty was not so much that he could not gain his objectives, but to know what these objectives were. All southern European Russia, including



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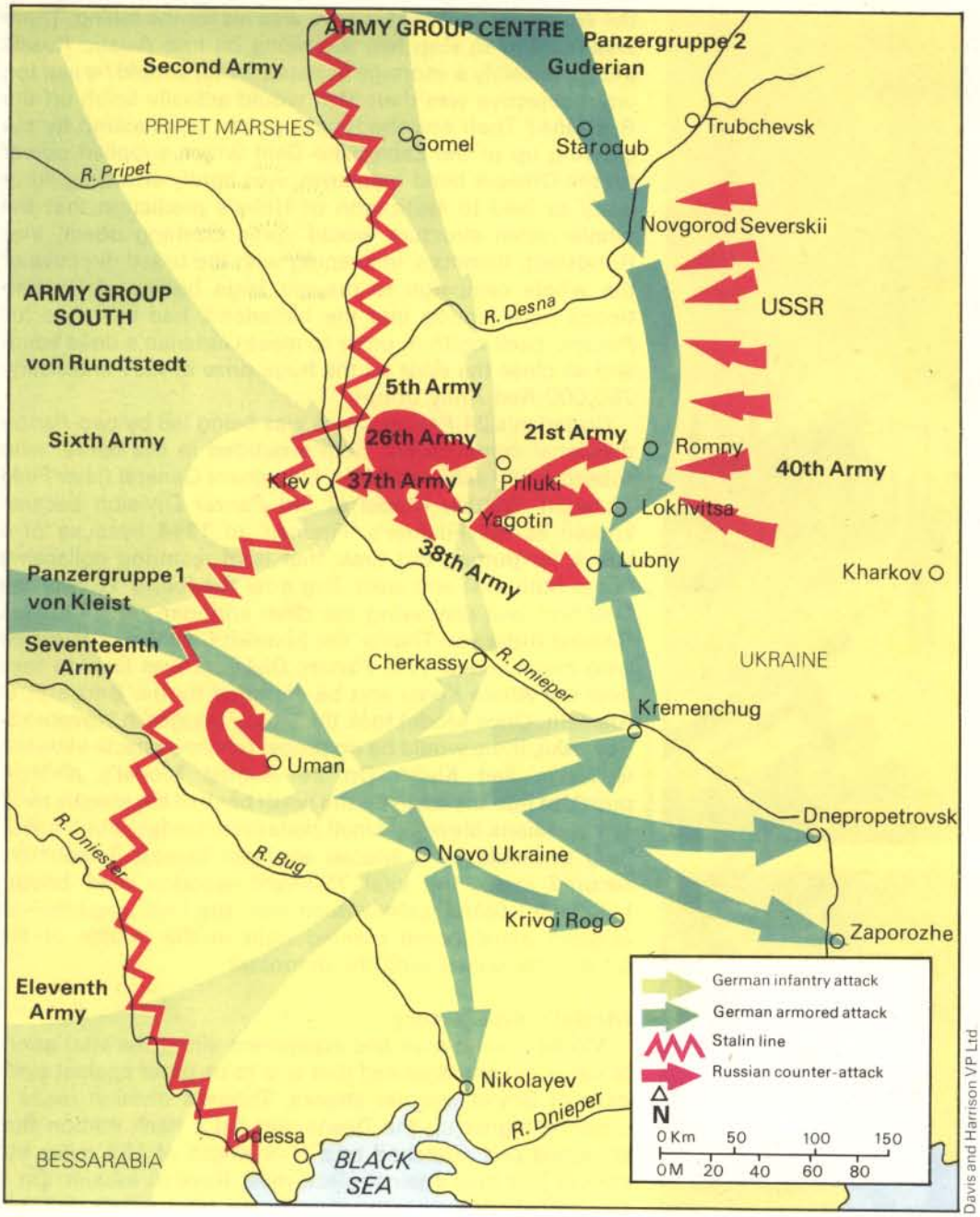
the whole of the Donets basin, was his for the taking. There was nothing to stop him swarming on into Asiatic Russia except possibly a shortage of petrol. What should he aim for, what objective was there that would actually finish off the Russians? Their scorched-earth policy, emphasized by the blowing up of the Zaporozhe Dam which supplied power for the Dnieper bend industries, was hardly encouraging or likely to lead to realization of Hitler's prediction that the whole rotten structure would come crashing down. Von Rundstedt, therefore, in keeping with the broad directive of the whole campaign to prevent large bodies of Russian troops from retiring into the hinterland, had switched his *Panzers* back north in order to meet Guderian's drive south and so close the door on the huge prize of Kiev and nearly 750,000 Red Army troops.

Guderian's 24 *Panzer* Corps was being led by two *Panzer* divisional commanders, both wounded in the battle, who subsequently achieved fame. Lieutenant General (later Field Marshal) Walther Model of 3rd *Panzer* Division became known as the Fuehrer's 'Fireman' of 1944 because of a knack for putting out fires, that is of restoring collapsing fronts both east and west. But now the future 'Lion of the Defence' was displaying the dash and elan of a Rommel. General Ritter von Thoma, the Spanish Civil War tank expert who commanded 17th *Panzer* Division, was later to take over the *Afrika Korps* and be captured by the British at El Alamein. Once Model took the Desna bridges at Novgorod-Severskii, there would be no proper terrain obstacle between Guderian and Kleist. On 26 August Model's division punched into the town on the north bank of the marshy river. The Russians blew the small pedestrian bridge, but a head-long scramble by a special engineer assault detachment secured intact the vital 750-yard wooden road bridge. Lieutenant Störck calmly dealt with the final obstacle—an adapted aerial bomb planted right in the middle of the bridge—by unscrewing the detonator.

Model's vital artery

Model poured men and equipment along the vital artery to carve out a bridgehead that was to be proof against eight days of Soviet counter-attacks. Thoma's division made a crossing higher up the Desna and led a flank cordon that stretched and stretched to a N-S length of 155 miles but always just held against piece-meal Russian assault. On 9 September, despite late summer torrential rainstorms that churned roads into quagmires and dwindling fuel supplies, 3rd *Panzer* Division captured Romny, the last town before the pincers' rendezvous.

Meanwhile Kleist was about to join up with Guderian. His pincer had been held back so long lest the Russians recognise the threat of double envelopment too soon. On 12 September, the day snow first fell on the Eastern front, 16th *Panzer* division sliced 43 miles north after breaking out of the bridgehead at Kremenchug. The division's infantry needed a day and a half to master Lubny, fiercely defended by workers' militia and NKVD secret police. The closing pincer spearheads were still 60 miles apart. By the 15th 3rd *Panzer* Division was down to 10 battle-ready tanks but under Guderian's stimulus had struggled on beyond Lokhivitsa while the bulk of its units were still mudbound along the road back to Romny. Reconnaissance parties from *Panzergruppen* made contact and on the 16th the greatest encirclement of the entire Russo-German conflict was achieved. Twenty-two days after the opening of the battle 50 Soviet divisions had been trapped. Three days earlier



Tactical perfection, the armor/infantry encircling of the Red Army's vast SW Theater after the partial enfolding of it at Uman. These two annihilating victories put 70 Soviet divisions out of the war, yet only involved about 30 German divisions from 145 in the Soviet Union. The Panzer *pincer arms of Guderian and Kleist began thrusts 400 miles apart to link up in three weeks according to plan. The Soviet 37th Army, around Kiev itself, never even got the belated breakout order (night 17/18 Sept.) and surrendered after two days street fighting. So complete was German air supremacy that organized retreat by day had become impossible. Many Russians gave up* en masse *and so eased the path of German tanks lost in the sheer space of the Ukraine. It was the greatest haul ever taken in warfare. Kleist's 48* Panzer *Corps alone took 109,000 POWs, more than the Tsarist Army lost at Tannenberg (1914). No wonder Soviet accounts of Kiev hint at 527,000 casualties, let alone 665,000 prisoners. Kiev gave von Runstedt two months unchecked advance, but made Hitler gamble on reaching Moscow before winter.*

Budenny, specially flown out, had finally been relieved of his command and Marshal Semyon K. Timoshenko, Stalin's indispensable 'rescue' general, appointed in his place.

From 16-19 September the Second and Seventeenth German infantry armies closed in on Yagotin, target of the inner ring of encirclement, while Sixth Army took Kiev on 20 September. For the next week what became known as the Kiev cauldron—originally about 130 miles wide and deep—which for all its efforts outside the Red Army was not able to burst into and meet the belated breakout efforts begun during the night of the 17th-18th, was broken up by the Germans. Some six Soviet armies (5th, 21st, 26th, 27th, 38th and 40th) were either wholly or partially destroyed. One army commander extracted just 500 survivors. Besides having no proper direction, the Russian soldiers simply had not enough ammunition or fuel—two indispensable commodities of modern war—to conduct a co-ordinated battle of any sort. Courage they did have and in a series of fanatical and desperate counter-attacks made by men down to five bullets apiece were simply annihilated. 'During the fighting the words of Stalin, magnified to gigantic proportions by the loudspeakers, rain down upon the men kneeling in holes behind the tripods of their machine-guns, din in the ears of the soldiers lying amid the shrubs, of the wounded writhing in agony upon the ground. The loudspeaker imbues that voice with a harsh, brutal, metallic quality. There is something diabolical, and at the same time terribly naive about these soldiers who fight to the death, spurred on by Stalin's speech on the Soviet Constitution. By the slow deliberate recital of the moral, social, political and military precepts of the Commissars, about these soldiers who never surrender; about these dead, scattered all around me; about the final gestures, the stubborn, violent gestures of those men who died so terribly lonely a death on this battlefield, amid the deafening roar of the cannon and the ceaseless blaring of the loudspeaker.'

The killing went on for the best part of a week, and then the surrenders began. Once they started they went on and

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on until over 600,000 Russian soldiers were prisoners. A colossal part of the Red Army, perhaps a third of its June 1941 strength, had been removed from the battle. It was not enough. No matter how many times the Hitler might trumpet that 'The Russian is finished', he obviously was not. The Russian Bear refused to lie down and expire. He insisted on fighting on. And within three months of their fantastic Kiev victory, something like despair was to grip leading German formations as they stumbled to a halt before Moscow and then began to withdraw.

Moscow 'only for ossified brains'

For irony of all ironies, having condemned his generals' notions of capturing Moscow in no moderate terms—'Only completely ossified brains, absorbed in the ideas of past centuries could see any worthwhile objective in taking the capital'—Hitler insisted Moscow be captured. But he still made the fatal mistake of trying to go for Leningrad and the Caucasus as well. Soon after resuming his advance in the center, *two months* since halting after the Smolensk battle, von Bock had taken another 600,000 prisoners and by 15 October his spearhead was at Mozhaisk, a mere 65 miles from the capital. If even at that point Hitler had gambled all, concentrating the dwindling tank strength of all four *Panzergruppen* on the drive for Moscow, while merely defending the northern and southern fronts, then surely victory—if by that we mean destruction of the Soviet armies defending Moscow and capture of the city itself—would have been within his grasp. Instead he failed to observe the never-to be-forgotten principles of singleness of purpose and concentration of resources to that end. By the time he had realized it, the chill breath of winter and defeat was breathing down the necks of ordinary soldier and High Command alike.

A question of ideology

From the Russian point of view the greatest numerical military catastrophe of their history was caused by Stalin's refusal to give up his regime's tenuous ideological grip on the Ukraine without a fight. Surely in this he may be judged right for to have chucked his hand in there would simply have given the Germans more time and resources to finish off the job in the center. Moscow's loss might well have brought about a total collapse of the Red Army's will to continue as opposed to the willingness of hundreds of thousands of its soldiers to surrender. The same sort of ideological and military question mark had also been half-posed In 1919 during the Russian Civil War when anti-Bolshevik forces were converging on Moscow from all points of the compass. But given that the Ukraine was to be defended in 1941, Budenny's defense ensured that had the Germans been allowed to choose their enemy's response they could not have done better. For the Germans indeed the battle was a brilliantly executed operation of war—the technical and tactical highpoint of the *blitzkrieg* era.

Yet strategically it was a flop. All the slaughter, all the advances, all the planning and controversy and triumph went for nothing. The magnitude of Russia's resources proved equal to the enormity of the loss. Four million out of her 10 million military casualties occurred in the first six months of almost four years fighting, but in 1941 alone four million reserves were mobilized. Kiev was a second Cannae —but as after the first the losing side would fight on to eventual and total victory.

John Strawson

Popperfoto

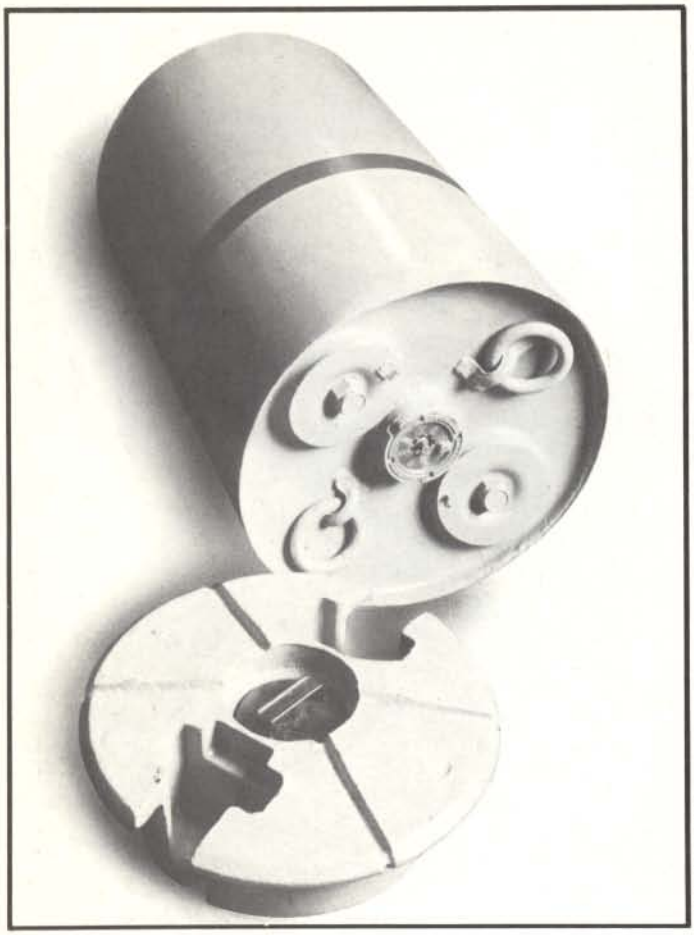
SCIENCE v. U-BOAT

Allied and Axis scientists were brought face-to-face in the struggle to beat the U-boat menace of 1940

In World War II, one of the first incidents of the war at sea was the torpedoing without warning of the British passenger liner *Athenia* by the German submarine *U30*. It took place on 9 September 1939 and signalled the renewal of all-out attack on the mercantile traffic of Britain and her Allies begun during the World War I. From May 1917, it had been brought under control by the introduction of a comprehensive convoy system. But before the end in November 1918 the Germans had made some progress towards defeating the defensive strength of such a system. They took advantage of the virtual invisibility of the low silhouette of a submarine by night to use them as surface torpedo-boats.

By diving after making their strike they were practically immune from counter-attack. No effective means of locating submerged submarines by surface ships had been discovered by the time war ended. They could be caught in fixed net defenses, or swept for by explosive or net sweeps. If they exposed themselves—even just their periscopes—they might be rammed by an alert warship. The area where they were seen could be plastered with depth-charges—one of which *might* explode within damaging or lethal range. But the only means of detecting the presence of a totally submerged submarine was by listening for the sound of its propellers on hydrophones. These were non-directional and their efficiency was reduced to nothing by movement through the water of the ship in which they were mounted. And a motionless ship in submarine-inhabited waters is highly vulnerable.

Research and experiment into methods of transmitting and receiving sound waves through sea water—and thus echo-ranging—had been made by French, British and American scientists. The most important advances were those made by the French physicist Paul Langevin in collaboration with a young Russian, Constantin Chilowsky. They concentrated their research on the use of the peculiar qualities of quartz crystals. A thin slab made up of a mosaic



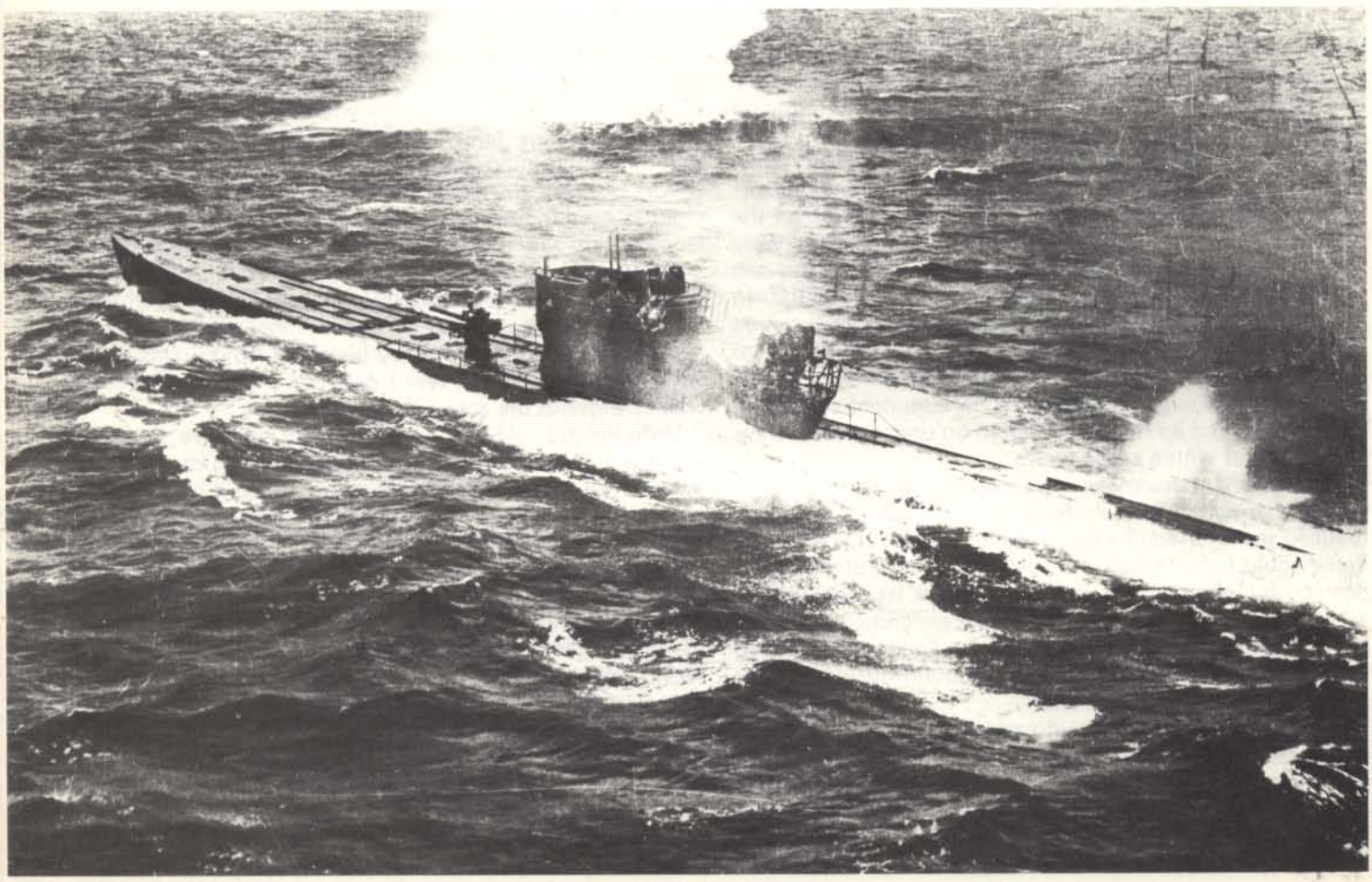
M.O.D./Eric North

of quartz, suitably sliced and sandwiched between thin steel plates, was used to generate and transmit ultrasonic waves electrically and to detect the echo returning from a solid, submerged object. With such an arrangement—known as a 'transducer'—they succeeded in picking up echoes from a submarine at a range up to 3,200 yards (2,925m).

The British team working on the same problem under the Canadian Professor R. W. Boyle were kept informed of these developments. In October 1918, an inter-Allied conference on submarine detection devices was held in Paris. Britain, France, Italy and the United States sent delegates. Only the British and Americans, however, continued to use the Langevin device after the end of the war. The French concentrated more upon the use of sound-ranging for the development of echo-sounders for navigational purposes.

British experimental work on submarine detection was carried on until 1920 at the Admiralty Experimental Station at Parkstone Quay, Harwich. It then moved to Portsmouth, Hampshire, where it stayed until 1927 when the Underwater Detection Establishment was set up at Portland alongside HMS *Osprey*, the 'stone frigate' training school for officers and ratings specializing in anti-submarine warfare. There,

◁◁ *British warship prepares to launch depth-charges in World War II, March 1943. This was very much a hit-or-miss affair. But British scientific advances later made accurate 'pin-pointing' of a U-boat possible.*
◁ *A typical British depth-charge. The end cap is weighted to ensure the device is quick-sinking and falls in the vertical position.*
▽ *The adversary—a surfaced U-boat under attack.*



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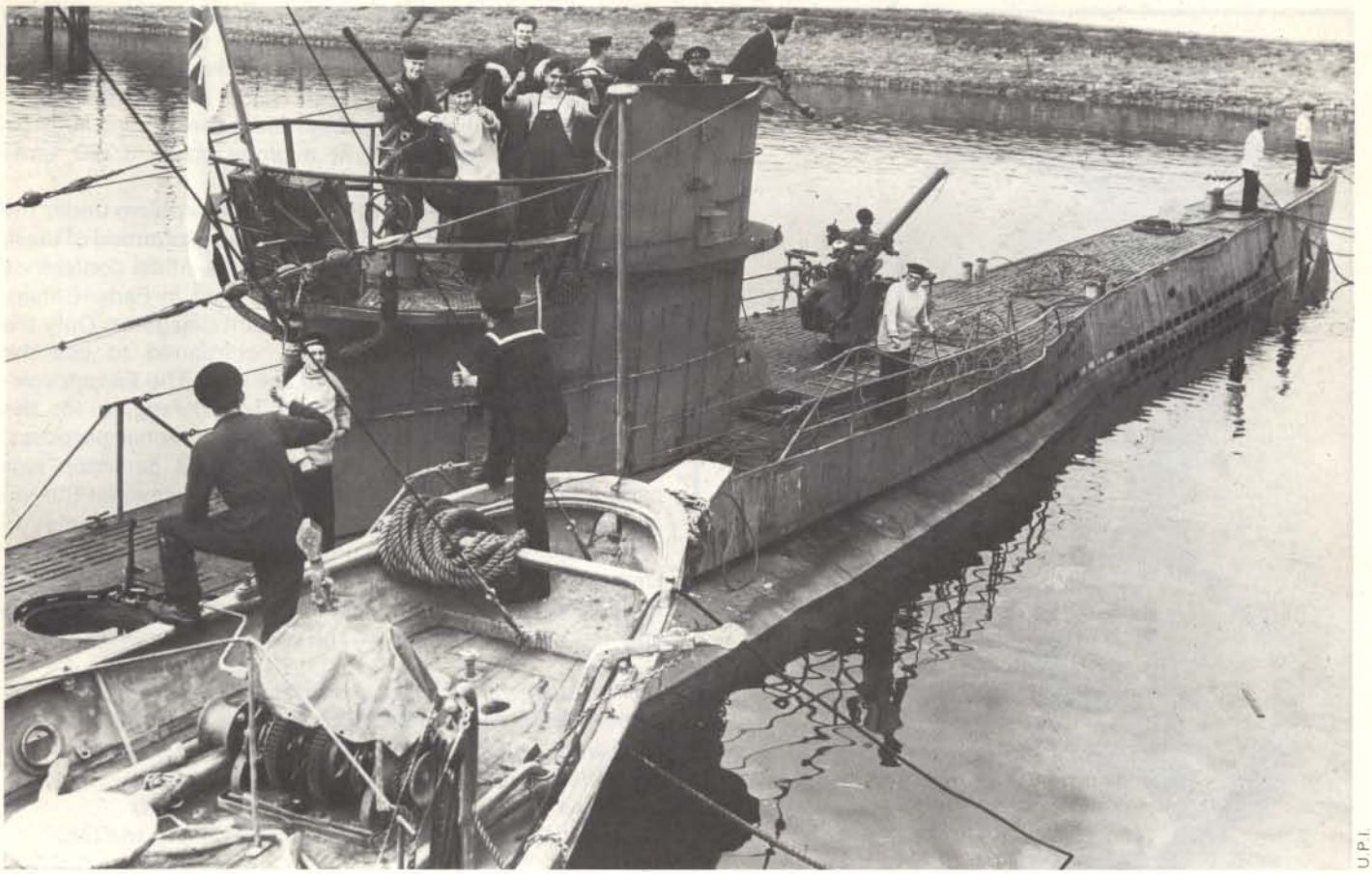


A type 7C U-boat—probably the U570*—is brought into a British port after capture in mid-Atlantic by an RAF Hudson. The RN ensign flies from the conning-tower gun-platform as bearded Lt George Colvin brings the prize into harbor.*

the echo-ranging sets using the Langevin principle were developed. They were given the name ASDIC after the initials of the Allied Submarine Detection Investigation Committee of 1918.

Technical progress between the wars was slow. Only meagre funds were allocated. But fortunately a few dedicated scientists continued to concentrate their minds on the development of echo-ranging. The two principals were B. S. Smith and John ('Jock') Anderson CB, CBE. They can justly claim the position of joint 'fathers' of ASDIC. In particular, Anderson is well remembered to any who served in the Portland Anti-Submarine Flotilla for his refusal to allow his chronic sea-sickness to deter him from his ceaseless ship-board experimentation in the turbulent waters off Portland Bill and its Race. He carried on undaunted, always with a bucket within easy reach.

Two important advances were made. A streamlined dome was developed in which to house the transducer. This reduced the interference by cavitation noises at speed. The dome could be withdrawn inside the hull to protect it from damage at high speeds or in rough weather. Its development was greatly helped by the fitting in the experimental ship of an observation dome. Inside, Jock Anderson installed himself—a position claustrophobic enough even for those not prone to sea-sickness.

The other main step forward was in the application of the data received to the problem of accurately delivering depth-charges in the vicinity of a moving target. In place of a simple stop-watch system of calculating range by measuring the time between transmission of the sound impulse and receipt of its echo, a chemical recorder was devized which charted on a moving paper both the range and the rate of change of range at any time. Combined with the indication of whether the target's course was 'closing' or 'opening', obtained from the difference of note of the transmission from that of the returning echo—known as the 'Doppler Shift'—it was possible to decide the right moment to launch the charges even though the echo from a submerged submarine faded within a range varying with the depth of the target.

The success achieved by this system under ideal conditions tempted an over-confident attitude to the submarine threat. It was considered by all but those in the know to have been largely dispelled by installing ASDIC sets in the large number of World War I destroyers held in reserve as well as those in the active fleet.

Unfortunately ASDIC was not very effective in rough weather because of the intermittent surfacing of the dome and the disturbance of the water flow round it by the ship's motion. It was almost totally useless in waters where the temperature varied sharply at depth—the sound beam being deflected in such conditions. Finally, ASDIC was unable to detect a submarine on the surface. This last characteristic, combined with a failure to appreciate the German trend towards night U-boat operations in the closing months of World War I, was to have a catastrophic effect in the first phase of the renewed German offensive.

When World War II began the British Navy was living in a fool's paradise. It had neither the necessary equipment to counteract the Germans' chosen tactic for convoy attack nor had it nearly enough escort vessels to implement the convoy system efficiently. The US Navy progressed even more slowly from the common point achieved by the Allied

committee in 1918. Their transducers were constructed on the magnetostrictive principle and did not use quartz. They were housed in a spherical rubber dome whose lack of streamlining restricted the effective speed of operation to a maximum of 10 knots. Also, they worked on the same frequency as one another. This meant that the transmissions of ships operating together produced mutual interference—causing considerable confusion.

At the time they entered the war, the US ships fitted with sonar—as the echo-ranging sets of both navies were to be called—had only a dial range indicator. The attack system this allowed was less efficient than that permitted by the chemical recorder in British ships.

The German Navy was plunged into war before it was ready. Its planned programme of expansion (Plan Z) was to have brought U-boat strength up to 250. In September 1939 there were only 37 U-boats, of which 27 were ocean-going types. German scientists had concentrated on improving the hydrophones fitted in these submarines. They were highly successful in this field, achieving a degree of sensitivity far in advance of the British. However, they had not been interested in echo-ranging. Surprisingly enough, considering the comparatively little attention paid to intelligence security by the British in that era, it was not until after the collapse of France, when British equipment fell into German hands, that any sure knowledge of it reached them. Most of the early U-boat losses therefore occurred as a result of attempts at submerged attack on escorted ships in daylight. After the spring of 1940 these became less and less frequent and were replaced by night surface attacks.

Kreigsmarine's 'useless' weapons

A field in which German technology failed disastrously in the early months of World War II was that of torpedo design. Like those of the British and US Navies they were air-driven, but they suffered from a faulty depth-keeping mechanism. Furthermore, magnetically operated firing devices were used for their warheads. These proved unreliable—as, indeed, did similar devices in the US and British Navies. The combination of these two defects resulted in a great many astounding failures for German U-boats after otherwise perfectly conducted attacks—particularly during the Norwegian campaign. These failures were heart-breaking for the German high command. Admiral Karl Donitz, head of the German U-boat arm, commented bitterly: 'I do not believe that ever in the history of war have men been sent against the enemy with such a useless weapon'. Later, however, it was replaced by a very dependable electrically-driven weapon. It left no track and had an effective contact-fired warhead.

When the Battle of the Atlantic really hotted up in the autumn and winter of 1940, U-boats operated in wolf-packs to attack convoys by night. They were opposed by inadequate escorts—often only two or three slow sloops, equipped only with star-shell to aid them in detecting their attackers. These proved useless for the purpose. Indeed, they did more harm than good in that the bridge personnel were blinded by the flash of the gun firing while the illuminant itself did nothing but destroy their night vision.

Another invaluable factor to the U-boat command was the breaking of the British naval cypher by German cryptanalysts. This enabled them to discover the routes and positions of convoys and to intercept them. The result was virtual annihilation of convoys on a number of occasions.

As the threat of German invasion of Britain receded, old destroyers were released from other duties to bolster the Atlantic convoys. Added muscle was given by the mass production of corvettes of the *Flower*-class. Despite their slow speed—less than the U-boat's maximum on the surface—and their small size which limited the anti-submarine weapons and devices they could accommodate, these craft were to comprise the back-bone of the escort force throughout the most critical days of the campaign.

But the total inability of the bridge personnel to locate the attacking U-boats was still the crucial factor. The boldest of the U-boat captains were taking advantage of this to penetrate right into the convoy columns where they could pick off victims at will. The obvious antidote was radar: but British development of this was a responsibility of the Royal Air Force under the leadership of Sir Robert Watson-Watt and was concentrated upon the provision of a type suitable for detection of aircraft. For this purpose, transmissions of radio waves of 12 to 13 metres or more was satisfactory. These required very large antennae and tall masts and were quite impossible to adapt for fitting on ships. But in the division of responsibilities in the radio field, the Admiralty Signal Establishment was given the task of developing radio valves. As a result of their researches, valves giving much greater power were evolved. Radar sets could now operate on wavelengths of between 50cms and $1\frac{1}{2}$ metres. An adaptation of an airborne search radar (ASV) working on the latter wavelength was fitted in a number of destroyer escorts in late 1940. However, its ability to detect submarines on the surface was negligible. The first finding of a U-boat by radar was recorded by a set of this type at a range of one mile on 17 March 1941. At the same moment it was detected by the naked eye.

The French, too, were involved in research and development of radar before the war and by 1939 their experimental shore-based sets working on a 16cm wavelength could pick up medium-sized ships at a range of up to six miles. These comparatively advanced techniques were passed to the British General Electric Company before all data was destroyed when the Germans advanced into France in May 1940.

German development of radar started at about the same time as the British and French. Sponsored by the *Kreigsmarine*, research was concentrated on a surface-warning capability—the main effort being with an 80cm wavelength. At the same time the GEMA Company was making promising progress using 13cms. The German Naval Signal School, however, insisted that all the firm's efforts should be concentrated on the longer wavelength. This decision was strengthened by the excellent aerial-detection capability of the sets developed. As a result, in 1938 *Reichsmarschall* Hermann Goering demanded production of 1,000 sets for the *Luftwaffe*. So it was that the ship-borne radar installed—primarily as gunnery ranging sets—in German surface ships was in the 80cm band. German research into centimetric radar was abandoned.

German radar developments

The German pocket-battleship *Graf Spee* made good use of her gunnery-ranging set during her brief career as a raider of British convoys. So did the battleships *Scharnhorst* and *Gneisenau* and the cruiser *Hipper*. At first, however, radar played no part in the U-boat campaign against the Allied convoys. The British, unable to locate their attackers, decided that, somehow, they must find a means of turning night into day. In an effort to do this a rocket providing

brilliant illumination was devised. These 'Snowflakes' were fitted in every ship in convoy as well as in the escorts.

It was intended that, at the start of an attack, every ship should fire these rockets. This was rarely if ever achieved. Snowflakes were sometimes used by individual escorts in action with surfaced U-boats. But the rockets more often betrayed a convoy when accidentally fired by someone stumbling round the darkened bridge of a merchant ship. Thus, through the winter of 1940-41 the U-boats held a clear advantage over the escort forces who were overwhelmed time and again by the pack attacks of their elusively invisible foes. U-boat commanders were to remember this period as the 'Happy Time'. In the spring of 1941 their complacency was shaken by the loss within a single week of their three top scoring 'aces'.

The Germans feared that the escorts were equipped with some new secret device. In fact, the escort groups had increased in strength and experience. When the operational area of the U-boats was shifted farther west—out of reach of escorts based in Britain—the convoys suffered heavily until a base was set up in Iceland.

British results—'spectacular'

At the same time, in England, the fundamental solution to the escorts' problem was being worked out by British scientists headed by Mark Oliphant—under Admiralty auspices. It was realized that for detection of surface craft or other objects, radar of 10cm or less wavelengths (or microwave) was essential. The difficulty was to work out a method of transmitting sufficient power. An answer was found in the resonant cavity magnetron invented by H. T. Randall and H. A. H. Boot. To quote from Sir Robert Watson-Watt's book, *The Pulse of Radar*: 'On 21 February 1940 the new device was successfully operated. The results were spectacular . . . it was clear that the output was not around the few watts of the past, not the previous world record of a few tens of watts, but very nearly half a kilowatt'.

When this first, crude device was redesigned and perfected by GEC technicians, it produced 50kw of peak power at 9.1cm. This output was doubled by the time the first set using the new device was fitted in the *Flower*-class corvette *Orchis* in March 1941. Meanwhile, details of the resonant cavity magnetron had been handed to the Americans who, by January 1941, had produced an airborne microwave radar able to detect a surfaced submarine at over three miles. By May, the American ship-borne version, the most successful S/G set, was being fitted in US warships.

An aid to the new radar was developed simultaneously in Britain and America. It was the Plan Position Indicator (PPI)—a visual display of the area round the transmitter provided by a cathode ray tube with an after-glow characteristic. Any detection appeared as a spot of light. Upon the screen the escort could see the massed convoy and the escorts scattered round its perimeter. Any fresh detection was immediately suspect. The scientists had succeeded in doing what illumination by rocket or star-shell had failed to do. They had virtually 'turned night into day' and deprived the U-boats of the invisibility by night which had been their chief asset—though the production and fitting of the new radar sets in escorts would not be completed until late 1942. Aircraft employed either on escort duties or on anti-U-boat patrol in support of the convoys did not get micro-wave radar until the spring of 1943.

The other major research by British scientists was aimed at taking advantage of the U-boats' tendency to frequent radio transmissions. This was necessary because of the system of centralized control of the U-boat fleet. To make sure that a particular convoy was intercepted, a number of U-boats would be disposed on a patrol line crosswise to the convoy's route. The first to sight or otherwise detect the convoy had to report it to U-boat HQ and then maintain contact while other U-boats were directed to form a wolf-pack. Each one had to report as it, too, made contact and as it went into the attack. It then had to report results, and the torpedoes and fuel remaining.

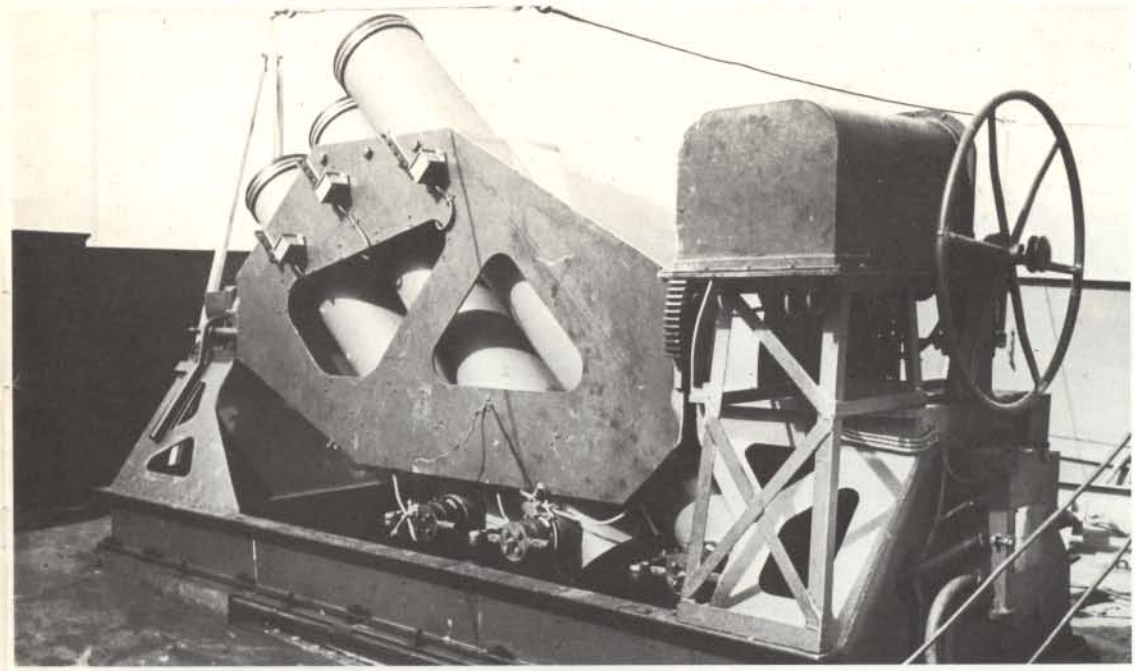
All these messages were made on high frequencies. British scientists had been trying since before the war to develop a ship-borne instrument to find the direction of such transmissions. In 1942 they perfected one which could be installed in the destroyer escorts. Before the system could be reliably useful, the problem of distinguishing between signals received direct on the ground wave, as it was called, and those received after reflection back to earth from the ionosphere had to be overcome. If the former, the transmitter was not more than 15 to 20 miles away, according to the height of the receiver's aerial. If the latter, it might be many hundreds of miles away and the volume of reception was no guide as to range. With the early high-frequency direction-finding sets, this discrimination depended upon the personal judgement of the operators. Some were experienced radio operators and had developed almost a sixth sense when it came to estimating range. Later sets provided an electronic visual aid to discrimination.

Limitation of reliable detection

The U-boats, however, could choose a number of frequencies on which to transmit. But though the choice depended largely upon the changing radio conditions at different times of the day, so that it could be to some extent forecast, it was not until it became possible to equip several ships in each escort force with high-frequency direction-finding (h/f d/f) sets that detection became fully reliable. At the same time it became possible to locate the transmitter with greater accuracy by means of cross-bearings from the detectors.

With the advent of microwave radar and h/f d/f, U-boats were surprised on the surface more and more often. Morale suffered severely as nobody could explain why they were being spotted so frequently. The existence of h/f d/f was never suspected. U-boats continued to transmit at will, giving instant and clear warning to an escort fitted with it that his convoy was being shadowed, together with a rough estimate of the shadower's position. The escort would race into attack. It might get radar detection so that it could destroy the U-boat. At least it would force the U-boat to submerge and—harassed by a sonar search—to stay down so long that it lost touch with the convoy. In this way the organization of the wolf-packs was frustrated and the convoys passed through the patrol lines unscathed.

The Germans did not find out that the Allies had developed microwave radar until 1943. An aircraft fitted with it was shot down and evidence of it was obtained from the wreckage. It was too late for them to use the information to build an operational set of their own. They realized that something of the sort was being used against them, however, when the radar warning device 'Metox', fitted in their U-boats to avoid being surprised on the surface by patrolling aircraft, failed them during their crossings through the Bay of Biscay on their way to or from patrol. This led them to



M.O.D.

◁ *A British naval anti-submarine mortar. The trajectory of the missile can be adjusted according to the position of the U-boat as detected by sonar pulses. At the beginning of World War II, U-boats wreaked havoc on Allied convoys in the Atlantic and North Sea. But they were in the end defeated by science.*
▽ *Two British weapons that played a crucial role in the defeat of the U-boat. Squid (left) fired from a mortar explodes at varying depths using hydrostatic fuzes. The Hedgehog (right) is fired in patterns to explode on contact.*

M.O.D./Eric North

adopt, for a period in June and July 1943, the tactics of remaining on the surface and fighting it out with the attacking aircraft. Disaster resulted. During those two months they lost 17 U-boats as a result of aerial attack in the Bay.

These two achievements by Allied scientists—microwave radar and h/f d/f—brought sonar into its own again. Forced to submerge by one or both, U-boats exposed themselves to sonar hunting. Their scientists sought for ways of deceiving sonar operators. A device known as *Pillenwerfer,* or, to the British, as 'Submarine Bubble Target', was developed. This was a canister containing a quantity of effervescent material which could be ejected to produce an area of bubbling water from which an echo of the sonar wave was returned. It was occasionally effective with an inexperienced sonar team; but the fact that it stayed still betrayed its falsity to the majority.

As the Battle of the Atlantic turned against the Germans, the U-boat commanders demanded a weapon to use against the escorts which were normally too fast or being too unpredictably maneuvered for an ordinary torpedo attack. Their scientists therefore devised an acoustic-homing torpedo—known to the escorts as a 'Gnat'. This had a speed of 23½ knots and 'homed' on to the noise of a ship's propellers. Achieving a measure of surprise on its production in the autumn of 1943, it dealt out painful losses at first. Indeed, although a simple mechanical antidote was soon produced in the form of a noise-maker towed at some distance astern to offer a greater sonic attraction, this interfered with the operation of the sonar and could not be kept continuously functioning. Right up to the end of the war the Gnat was scoring occasional successes.

Another type of torpedo issued to U-boats was the 'Lut' which could be set to run straight for a given distance into the center of a convoy and then adopt a pre-set zig-zag course with a good chance of finding a target amidst the formation of ships.

The U-boat's best protection against the combination of sonar and depth-charge, however, was the inability of the sonar to measure the depth of a target and the U-boat's own ability to dive to a depth of more than 600ft. This was

THE SONAR/HEDGEHOG COMBINATION

Peter Sarson/Tony Bryan

much deeper than any British submarine of that period could dive. The latter was not realized by British naval authorities until *U570* was captured intact in August 1941. It was commissioned in the Royal Navy as HMS *Graph* and exhaustively tested. Depth-charges, which until then could be set to fire at a maximum of 350ft, were adapted to sink to 700ft before exploding. But this did not solve the two problems of selecting the right depth to set on the charges and of forecasting the correct position to drop them so that, as they sank, they intercepted their moving target.

To understand the difficulty, the characteristics of sonar need to be looked at in greater detail. The sonar waves were transmitted in a cone-shaped beam, rotatable in the horizontal plane but fixed in the vertical at such an angle that the target as it was approached, disappeared below the lower limit of the cone and ceased to send back echoes. When attacking with depth-charges launched from the stern, this produced a blind period or 'dead-time', when contact was lost. This not only introduced a large measure of hit and miss into estimating the time to fire, but gave the submarine the chance to take undetected evasive action. The greater the depth of the target, the greater the 'dead-time'. And though the range at which contact was lost thus gave an estimation of the target's depth, a lot was left to guess-work in setting the firing depth on the charges.

The combination of these two shortcomings of sonar gave a skilful U-boat commander a good chance of avoiding destruction or serious damage if he took his boat to its maximum depth and used the 'dead-time' to take evasive action. A long hunt to exhaustion, holding sonar contact until the U-boat was forced to surface was one answer to such tactics. But escorts attached to a convoy could not usually be spared for so long. Another was the 'creeping attack'. One ship held contact from astern of the U-boat so that the sonar transmissions could not be heard through the wake. Another was then directed to overtake the target. The moment this ship was the right distance ahead of the target, a series of depth-charges set to maximum depth was released by her at the order of the directing ship. The method was, on occasion, spectacularly successful.

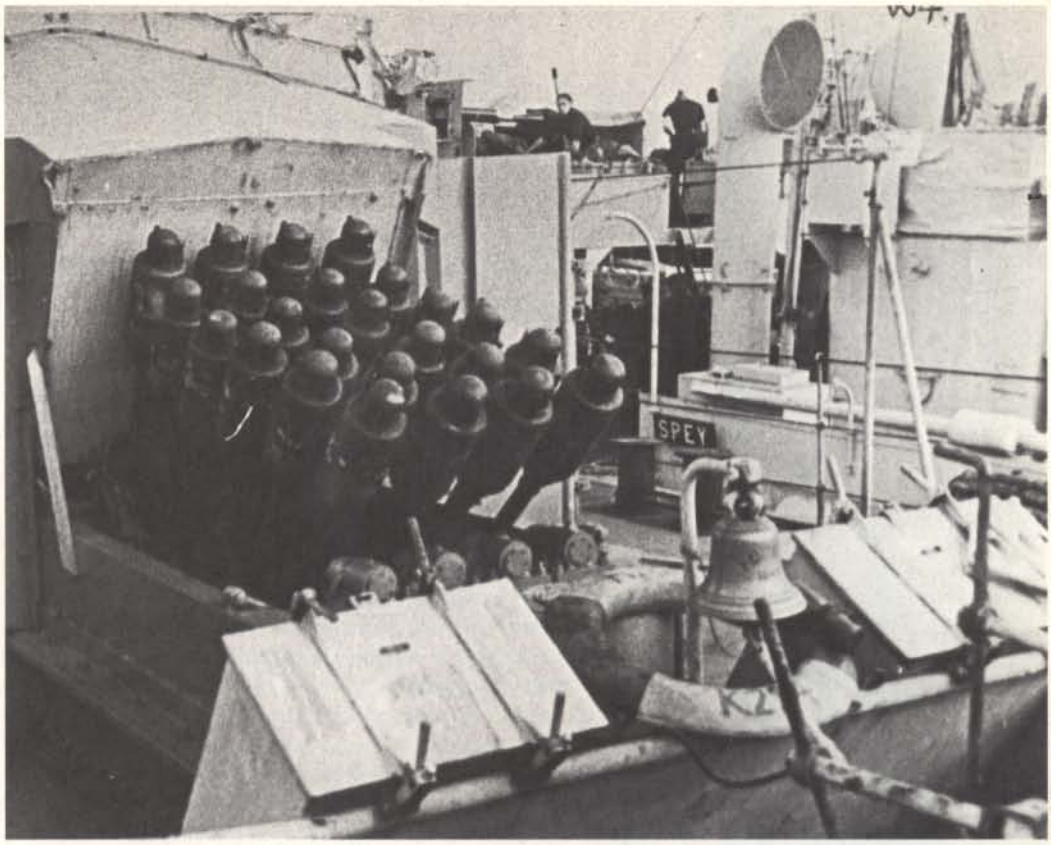
British scientists and technicians again lent assistance in the anti-U-boat war, however. To enable the depth of a target to be measured, an auxiliary transducer was fitted which transmitted its sonar waves in a flat fan-shape. The vertical angle at which this was transmitted could be varied and measured. This—in combination with the known range—gave depth.

To avoid the uncertainties of the 'dead-time', a method of throwing the depth-charges ahead of the ship was necessary. The first device evolved for this was the 'Hedgehog',

▷ *A Hedgehog launcher on the deck of HMS* Spey*—a River-class frigate. The launcher fired 24 bombs at once, surrounding the U-boat's position with a pattern. The bombs would explode on contact and if the pattern fell right it was probable that one would score a hit.*

◁ *The green area on this three-dimensional diagram is the sonar pulse. It pin-points a U-boat's position. Hedgehog bombs are launched to cover the same area. Here, one bomb has struck the U-boat's stern, to explode on contact. Such a hit, if not destroying the enemy, would force it to surface where it would be under attack from the frigate's main armament, where weight of fire-power would be on the side of the British vessel. The development of sonar made the detection and destruction of U-boats an operation of great accuracy. So much so that it led to Germany losing the war at sea.*

▽▷ *The Hedgehog, cutaway to show the fuze detail and charges.*



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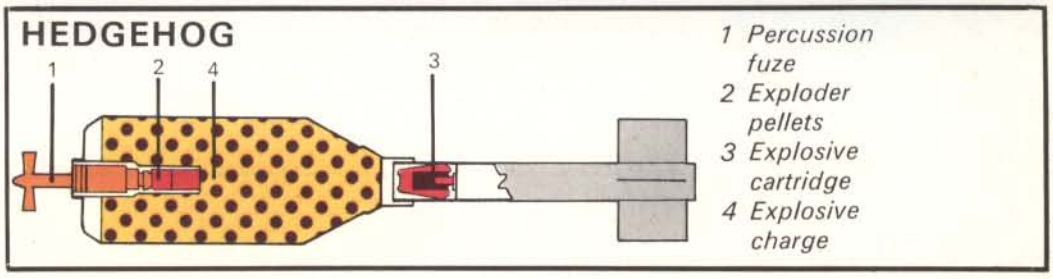

Peter Sarson/Tony Bryan

introduced in 1943. It projected 24 small, contact-fused bombs to a range of 250 yards. A hit with one of these was enough to shatter the submarine's pressure hull and destroy her. But it required an accurate prediction of the target's movements during the 'dead-time'; so the chances of such a hit shrank with the target's depth. Therefore, the weapon was only really reliable when the U-boat was not far down. Furthermore, a near-miss achieved nothing, unlike a depth-charge attack in which damage sufficient to destroy or to force the U-boat to surface could result from a number of near misses.

Towards the end of the war a weapon which made good the short-comings of the 'Hedgehog' was produced—the 'Squid'. This was a multiple mortar which threw three quick-sinking depth-charges to a range of 275 yards. Combined with the depth-finding sonar set and an improved system of control, it was to prove deadly.

German technologists had meanwhile been far from idle. But in every field they were outstripped by their British counterparts. We have seen how the acoustic-homing torpedo only came into production after the back of the U-boat effort had been broken in the spring of 1943 and how it was successfully countered. Similarly, when Holland was over-run the Germans had captured examples of the Dutch pre-war invention, the *schnorkel* breathing tube. This device enabled a submarine to run on her diesel engines and to recharge storage batteries without surfacing. This could have given them a large degree of protection against being picked up by radar—either ship or airborne. But it was not until 1944 that the first U-boats were fitted—too late to reverse the outcome of the Battle of the Atlantic, though it did enable U-boats to wage a later campaign of harassment in inshore waters.

More significant—had they been developed earlier—were the new types of U-boat with a high submerged speed—the Type 21. They achieved this by means of very light, high-capacity storage batteries which gave them a submerged speed of 17½ knots. Several hundred of these were under construction at the end of the war but none was operational. The other project which had nearly reached the production stage at the end of the war was the Type 17 U-boat, driven by an engine invented by Professor Walter. It used hydrogen peroxide for fuel and gave a submerged speed of 25 knots.

Such craft would have posed tremendous problems for Allied anti-submarine ships at the end of the war. Fortunately for them, however, the scientists and technologists backing the Allies had managed to get and keep ahead of their German rivals. It is fair to say that the Allies owed their victory at sea more to this fact than to any other.

Donald Macintyre

Georg von Rauch

CHACO WAR

Two South American states erupt in jungle warfare

Over three years, the Chaco War (1932-35) engaged nearly 400,000 men and caused the death of nearly one in four of these. It was the first jungle war to be fought with modern weapons. Yet the major powers ignored its lessons and history has largely forgotten it.

The Chaco Boreal is the largest portion of the Gran Chaco —a barren wasteland of rough pasture, scrubland and stunted trees. It is arid and waterless for nine months of the year and a sea of mud during the rains of the southern summer. Occupying a roughly triangular area between the Paraguay and Pilcomayo rivers and the foothills of the Andes, it forms a natural barrier between Bolivia and Paraguay—the only landlocked nations in the Americas.

Paraguay emerged bankrupt and nationally exhausted from the dreadful war (1864-70) against the Triple Alliance of Argentina, Brazil and Uruguay. For many years after, she was effectively an economic dependency of Argentina. Argentinian firms engaging in cattle raising, lumber and the production of Quebracho extract used in the tanning of hides, began the commercial exploitation of the area adjoining the Paraguay river. To protect these interests from

Georg von Rauch

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◁△ Known to his Bolivian foes as 'Pila', this Paraguayan infantryman is somewhat shabby by conventional military standards. But his olive-green uniform and cotton sun hat proved eminently suitable for combat in the intense heat of the Chaco.
△ The Bolivian infantryman ('Repete') was certainly better dressed and equipped than his adversary. But his heavy khaki uniform made fighting in the heat an exhausting experience.
▷ Bolivian soldiers return to a look-out post hollowed in a Palo Borracho tree. They are equipped with Schmeisser sub-machine guns.
◁ Our map shows the disputed territory. Bolivia needed access to the sea. Paraguay, on the other hand, was already exploiting the Chaco. The war gave lessons for the future.

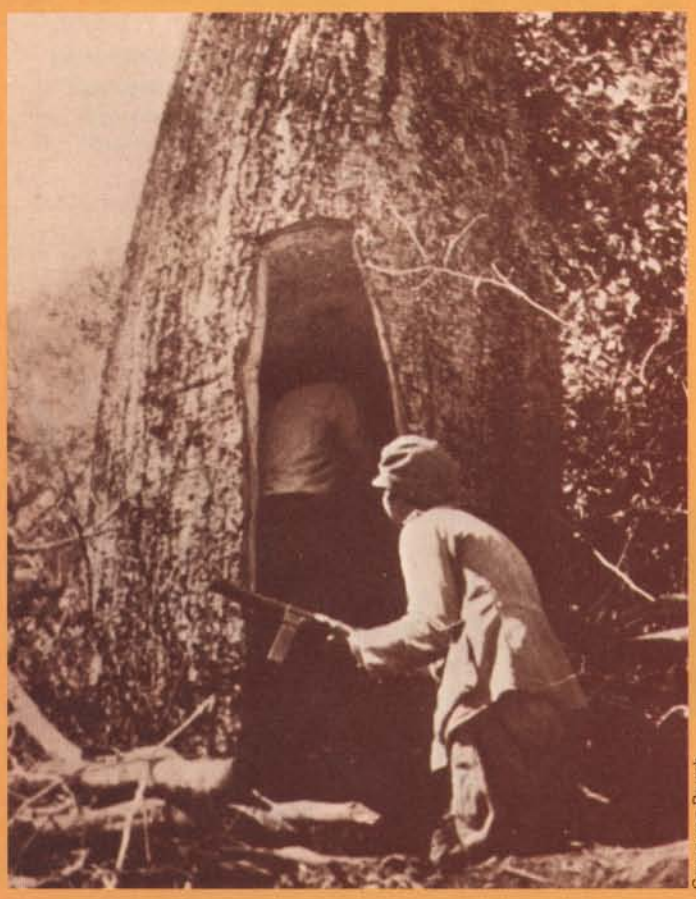
marauding Indians and to underline their claim to this newly important part of the national territory, the Paraguayans re-established small garrisons in the abandoned fortifications of Bahia Negra and Olimpo on the Upper Paraguay.

In 1883 Bolivia lost her small Pacific War. Deprived of its only outlet to world markets, this mineral-rich Andean nation, cut off in its landlocked mountains, experienced the first stirrings of national claustrophobia.

The French Military Mission—engaged by Bolivia in 1905 to modernize her ramshackle army—was replaced in 1911 by a German mission led by Major Hans Kundt. This mission returned to defend the Fatherland in 1914. At the end of World War I, Kundt found little call for his martial talents in post Versailles Treaty Germany. He readily assented to return to Bolivia to take command of the Army with the rank of General, assuming Bolivian citizenship to circumvent the Treaty restrictions.

In 1924, Paraguay reorganized her Army and embarked on an ambitious programme of arms procurement. The arrival of a French military mission in 1925 drew unwelcome attention to Paraguay's re-armament plans—hitherto shrouded in elaborate secrecy. In 1927 Bolivia openly contracted a supply of arms and equipment valued at over £2 million from Vickers of Britain.

An incident in December 1928, when Paraguayan forces on the Upper Paraguay, in defiance of standing orders to avoid provocation of the Bolivians, attacked and captured two Bolivian military posts (*fortines*), provoked swift retaliation from the Bolivians. They took two Paraguayan posts in the Lower Pilcomayo region and bombed the Paraguayan base at Bahia Negra—where the aggression originated. Diplomatic relations were broken off. Both countries ordered the mobilization of their armies. At that time, the Bolivian Army numbered 8,000 men to Paraguay's pre-mobilization strength of 3,000. Paraguay had a recruiting target of 10,000. This was not met because of lack of arms and insufficient barrack facilities.



Georg von Rauch

Frontier incidents continued and multiplied. The discovery by the Bolivians of a large fresh-water lake in the central Chaco in 1930 made possible the completion of a chain of *fortines* linking both rivers. This allowed military operations to take place away from what had previously been supposed to be the only abundant sources of drinkable water.

June 1932 saw the Bolivians establishing a post on the eastern shore of this lake. A small Paraguayan post established there shortly beforehand was dislodged. Having resisted puny attempts to force them out, the Bolivians withdrew to stronger positions on the opposite shore of the lake—still dominating the vital water supply. The incident developed into a full-scale battle. Attention was focussed on the strategic importance of the lake. The Paraguayans mounted an attack in strength with a reinforced battalion group. This numbered over 400, with cavalry and mortar support and succeeded in dislodging the Bolivians with heavy casualties on 16 July.

The slow fuse sputtering since 1928 now flared up. Peace talks in Washington under the auspices of the Organization for American Reconciliation, a forerunner of the Organization for American States, broke down. Both countries ordered the mobilization of their armies.

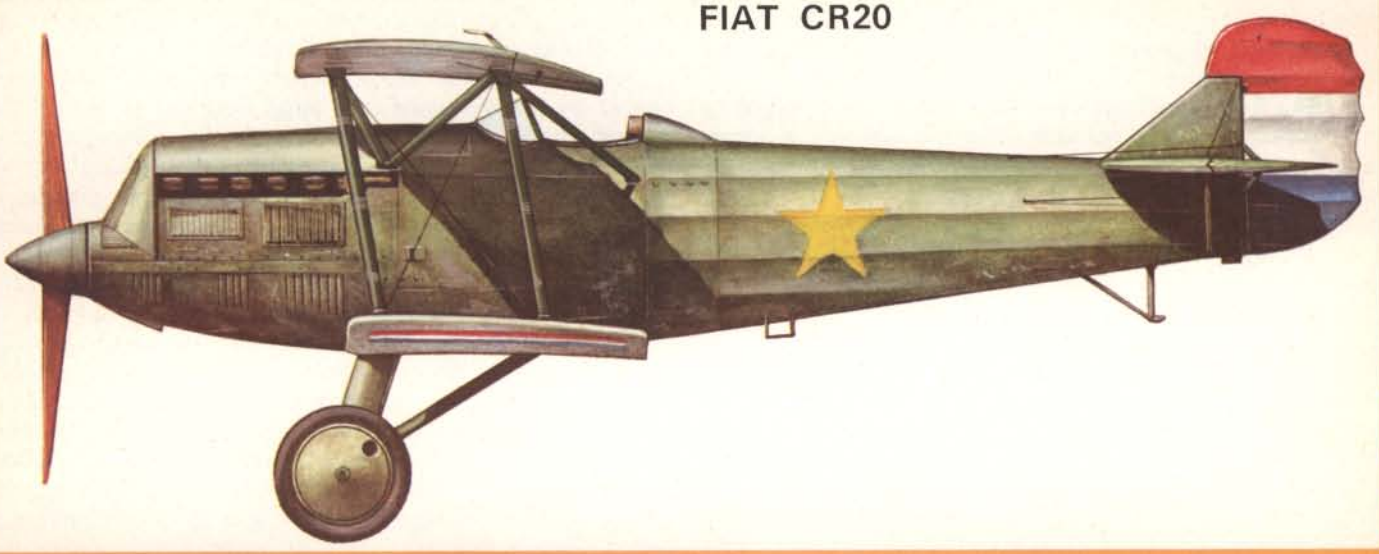
Bolivia's antiquated artillery

Bolivia's mining based economy was by this time feeling the effects of the Depression. Her population numbered about 3,000,000. Her army, theoretically 12,000 strong, in fact numbered fewer than 6,000—organized in six nominal divisions. The three weakest were stationed in the Chaco. Contrary to the belief of the Paraguayans, 50,000 usable rifles, 300 MGs and some 80 pieces of antiquated artillery were available to the Bolivians. Her airforce, however, with 60 modern aircraft, was one of the best in South America. Also available were small numbers of tanks, flame-throwers and AA guns. Such modern artifacts were far beyond the means of the Paraguayans.

Paraguay was relatively immune to international economic pressure. But she had already exhausted most of her slender financial resources in preparations for the coming war. Her population was just under a million and her 5,000-strong army—organized in one division with another in process of formation—was armed with about 24,000 modern rifles, 10,000 of which were of Spanish manufacture and inferior quality; 400 automatic weapons; 24 81mm Stokes-Brandt mortars (which had no counterpart in the Bolivian army and were greatly feared); and about 50 pieces of artillery, which included eight 105mm and 24 75mm Schneider pack howitzers of the latest French pattern. Her river Navy had recently taken delivery of two Italian armored gunboats, in addition to the half dozen or so elderly patrol craft already on hand. It also possessed a Marine Corps and its own tiny Air Arm, which included two relatively modern fighter floatplanes. The Air Force, which was part of the Army, had less than a dozen antiquated aircraft.

Since her heartland was closer to the disputed region than Bolivia's, Paraguay had built up substantial forces in the Chaco by the end of August. The 1st Army Corps at Isla Poi, some 18½ miles beyond the head of the Casado Railway—the main line of communication westward from the Para-

FIAT CR20



Peter Sarson/Tony Bryan

US National Archives

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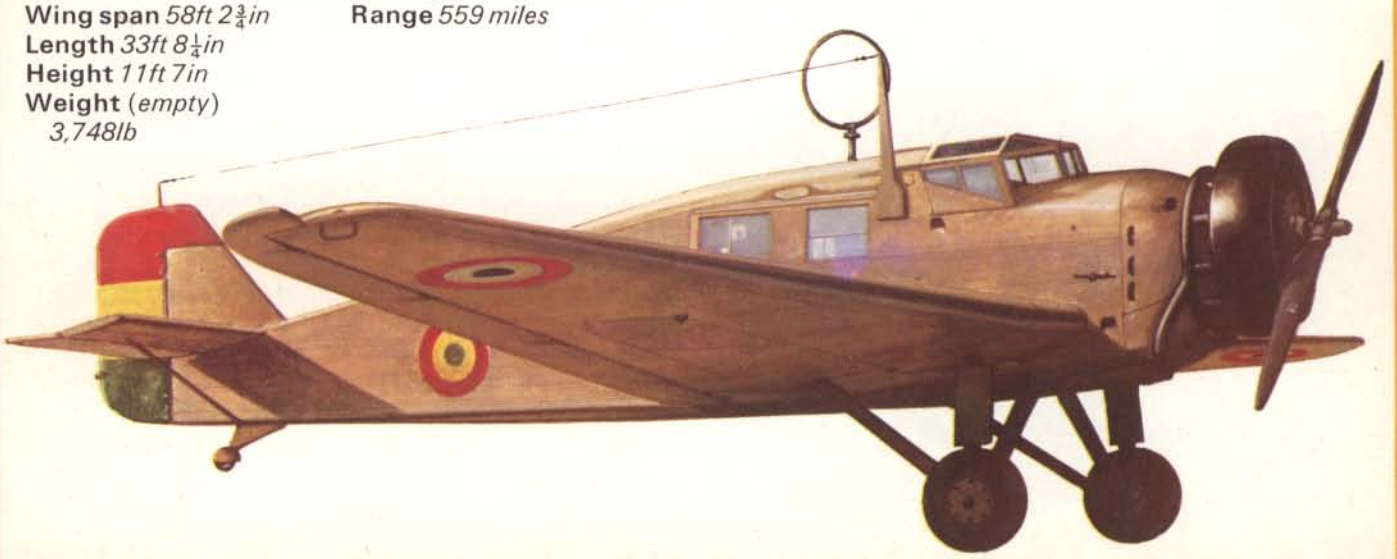
△ *Men of the Paraguayan Airforce, accompanied by members of the French Training Mission, pose in front of one of their Morane Soulnier 139 Trainer Aircraft. The picture was taken before the outbreak of the Chaco War.*
▽ *The Ju W34/hi of the Bolivian Air Force.*

△ *The days before concrete runways provided difficulties for heavy aircraft. This Ju52/3m was bogged down until an improvised runway could be made. Here, Bolivian soldiers are laying a take-off path for the well-known trimotor, using hundreds of cowhides.*

JUNKERS JU W34/HI

Engine *660hp BMW 132 radial*
Wing span *58ft 2¾in*
Length *33ft 8¼in*
Height *11ft 7in*
Weight (*empty*) *3,748lb*
Max speed *165mph*
Ceiling *20,760ft*
Range *559 miles*



Peter Sarson/Tony Bryan

◁ *One of Paraguay's Fiat CR20 fighters.* Engine: *one 450hp Isotta-Fraschini Asso 12-cylinder Vee type.* Wing span: *32ft 1¾in.* Length: *22ft 0¼in.* Height: *9ft 1¾in.* Weight: *3,278lb.* Maximum speed: *155mph at 6,562ft.* Service ceiling: *16,404ft.* Range: *311 miles.* Armament: *two .303in Vickers machine-guns. These were mounted in the upper front fuselage.*

▷ *Paraguayan Army Cadets in training with a 1907 model Krupp mountain-gun. These comic-opera looking young soldiers, complete with* pickelhaube *helmets, were not dressed for jungle war.*

Georg von Rauch

guay river — had completed the early stages of organization and numbered some 8,000 men with 24 pieces of modern artillery. A detachment of 1,500 men had been built up at the strategically important fort of Nanawa in the south-west. Meanwhile, 3rd Division on the Upper Paraguay—made up mainly of Marines and disembarked sailors with eight new Schneider guns and some antiquated emplaced artillery—numbered 3,000. A further 3,000 reinforcements were *en route* for the zone of operations.

Bolivia had about 4,000 men in her 1st Army Corps in the south west, and approximately 2,000 in two divisions in the NE. A further 6,000 troops had been detained on their way from Bolivia. Their government under-rated the military strength of the Paraguayans as persistently as the latter in their turn over-rated the opposing forces.

The Paraguayans reopened hostilities with an offensive against the *fortine* of Boqueron. This stronghold had been taken by the Bolivians in July and was the most advanced position held by them.

After an epic three-week defense, Lieutenant Colonel Marzana's 400-man garrison (with three old field guns, for which scarcely any ammunition existed, and some 40 automatic weapons), had been reinforced to almost 900. But this could not prevent encirclement by a Paraguayan force of 10,000 men with mortars and plentiful modern artillery. Weak relief forces of 3,000 men with limited artillery, under Colonel Enrique Penaranda, failed to raise the siege. Attempts to supply the beleagured garrison by air drop also failed. On 29 September, Marzana surrendered the thirsty, starving survivors. Losses on each side totalled 2,000. In the case of Bolivia, this was a catastrophic 50 per cent of her available forces.

After the shambles of Boqueron, Bolivia dismissed her Chief of Staff. He was unjustly blamed for the country's military unpreparedness. General Kundt was recalled from the exile in which he had taken refuge after abortive political meddling two years earlier.

As Penarada fell back towards Ballivian, the main Bolivian stronghold in the Chaco, half his surviving 2,000 men either mutinied or deserted. At the end of October, Bolivian President Daniel Salamanca ordered the consolidation of a defensive line from Munoz to Platinillos to await reinforcements from the Bolivian Altiplano. An outbreak of influenza in the Paraguayan army slowed its pursuit and prevented the destruction of the surviving tenth of Penaranda's force.

On 6 December, Kundt assumed command of the Bolivian field army. He began to rebuild it into something like a fighting force.

The Paraguayans also reorganized their victorious army. A second Army Corps was formed and the augmented field army was re-deployed in the region of Nanawa. Its defenses were greatly strengthened under the direction of the White Russian advisors of Colonel Jose Felix Estigarribia, the French-trained commander of Paraguay's field forces.

On 27 December Kundt reopened hostilities with frontal attacks by three divisions—totalling 9,000 men—on the Paraguayan positions at Alihuata-Nanawa. After 10 days of slaughter, in which 2,000 Bolivians died for the loss of 250 Paraguayans with no significant territorial gains, both armies settled into a sterile war of position until March. By now, a third Army Corps had joined the defenders of Nanawa.

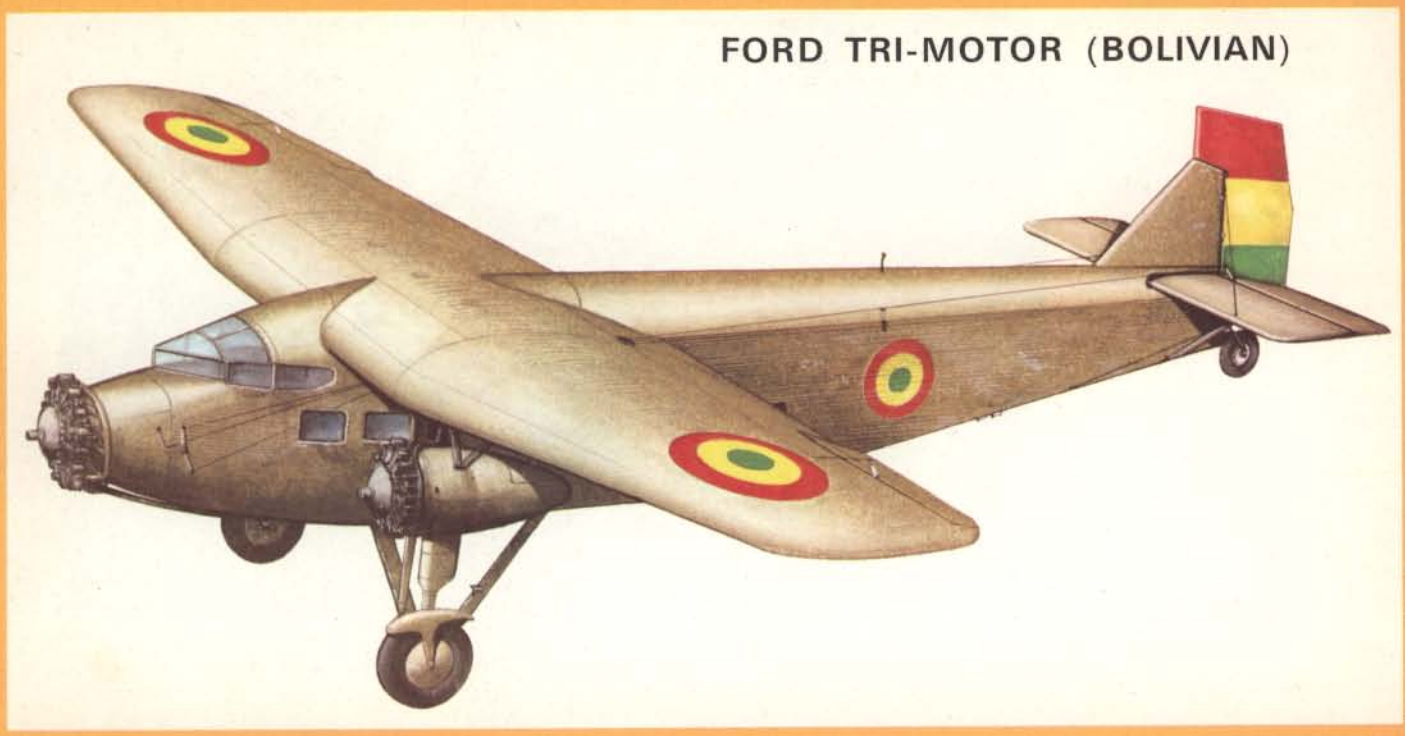
On 10 May 1933, after full-scale fighting over a period of 10 months, Paraguay declared war on Bolivia. The chief object of this was to enforce a policy of strict neutrality on the part of Chile, Peru and Brazil—who all served as useful sources of supply to Bolivia. This was not spectacularly successful. Chile's liberal definition of 'neutrality' was more than offest by Argentina's benevolent attitude towards Paraguay.

His army now reinforced to 12,000 men, despite his earlier heavy losses, Kundt launched the heaviest frontal offensive of the war—against Nanawa on 4 July. He committed 7,000 infantry with heavy artillery, tank and air support and employed six flame-throwers. This assault was as much a failure as the others—once more resulting in losses of over 2,000.

Stability returned to the front for two months until a limited tactical offensive by Estigarribia, in September, resulted in unexpected success. A thousand members of the Bolivian 9th Division were isolated and captured at Pampa Grande on the 14th.

Having responded to the sensible urgings of his Bolivian subordinates and shortened his lines, Kundt left for La Paz, the Bolivian capital. The people's faith in their Teutonic messiah was undimmed: he was feted as a hero.

FORD TRI-MOTOR (BOLIVIAN)



Peter Sarson/Tony Bryan

On 23 October, the Paraguayans mounted a massive counter-offensive with over 13,000 men—breaking the Bolivian lines with comparative ease, the enemy being even thinner on the ground than usual—Kundt had granted leave to large numbers of his men. A series of contradictory orders from Kundt added to the confusion.

The broken Bolivians made a fighting retreat in fair order towards Munoz. Victory for the Paraguayans was made certain by the isolation of two Bolivian divisions at Campo Via. Their water supply exhausted and with no hope of escape, 8,000 Bolivian troops and their equipment, surrendered on 11 December. They gave the Paraguayans their greatest single victory of the whole war.

Penaranda, with 2,500 men—the only survivors of Bolivia's field army—evaded capture. He went to Saavedra to organize new defenses.

This calamity destroyed any confidence the long-suffering Bolivian Government still had in the disaster-prone Kundt. He was replaced by Penaranda, who was promoted brigadier-general in recognition of his new eminence. The Paraguayan Estigarribia, a brigadier after Pampa Grande, now became a major general.

After the battle of Campo Via, both armies were exhausted. Consequently, suggestions for a truce by both the South American Neutrals and the League of Nations, who in their separate endeavors were striving to bring the adversaries to the conference table, were favorably received by both sides. The Truce was to begin at midnight on 9 December. Shortly before this, after an intensive artillery bombardment, the Paraguayans took Munoz, the crucial Bolivian Advance HQ.

During the first year and a half of the war, Bolivia had mobilized and transported 77,000 men to the Chaco. By December 1933 only 7,000 remained in the combat area. Eight thousand more were held in the rear, or manned the straggling lines of communication. Despite substantial losses, Paraguay still had 22,000 fighting men—only 4,000 fewer than at the time of her maximum strength in January.

The Bolivians also suffered crippling losses of equipment. Twelve-thousand rifles, 800 automatic weapons, 25 mortars, 20 pieces of artillery and 30 aircraft had been lost by December 1933.

To replenish these, 60,000 rifles, over 1,000 automatic weapons and more than 100 new Vickers guns of 65mm, 75mm and 105mm calibre were acquired during the December Truce. Approximately 30 Curtiss Hawk, Falcon and Osprey planes from the US more than made up for the losses suffered during the first phase of the war.

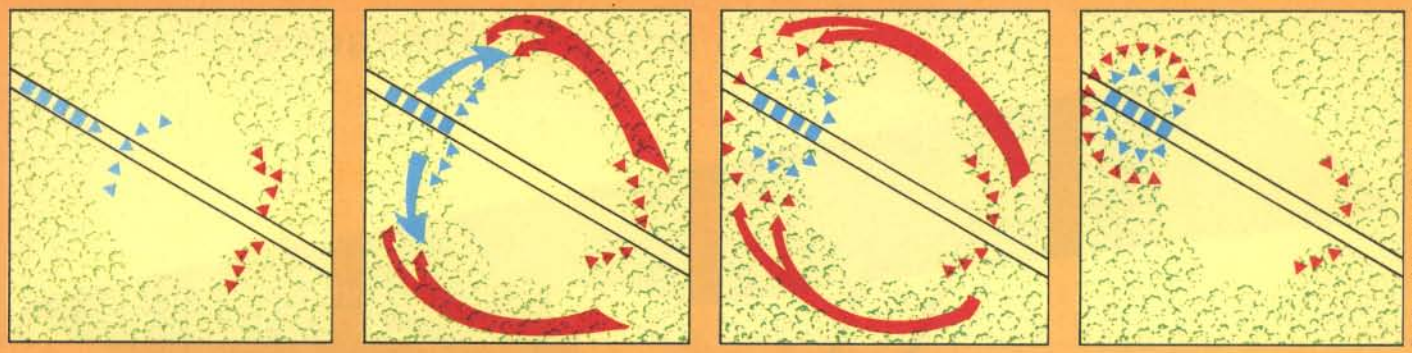
Bolivia used the truce period to regroup and reform her battered forces. Field HQ was established at Ballivian, where the two-division 1st Corps was re-deployed. The new defensive system was completed by the 2nd Corps—whose two divisions extended in a flattened arc to the NE. Strength in this sector rose to 20,000 men.

Paraguay also re-deployed her main force. The three-division 3rd Corps was moved to Munoz and the elite 1st Corps, also with three divisions, was deployed in the area around Platanillos. The small 2nd Corps, with one infantry and one cavalry division, was relocated at Toledo. The 9th Division was retained as Command Reserve.

Full-scale operations did not resume immediately after the end of the truce on 6 January 1934—the Paraguayan advance being temporarily held up for lack of transport. Meanwhile, the strained relations between the Bolivian military and civilian leadership took a turn for the worse. An unsuccessful rebellion by the cadets of the Military College in La Paz fuelled the fire.

By early May the Paraguayan 1st Corps had caught up with the Bolivian 2nd Corps in its well-prepared defensive positions. Reinforcements of two divisions from the southern sector allowed Bolivia to attempt a double envelopment. This was partially successful—resulting in the isolation and capture of 1,500 men of the Paraguayan 2nd Division at Canada Strongest on 25 May.

Preliminary skirmishing, although inconclusive, persuaded Penaranda that the small strategic importance of Ballivian did not justify the cost of defending it. He therefore moved his headquarters back to Guachalla. Colonel Toro, in charge at Ballivian, refused to withdraw his 16,000-man



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△ *Diagram shows a typical combat situation in the Chaco War. 'Blue' force, preceded by scouts, moves through the jungle into an area of dried-up swamp. They are immediately fired on by 'Orange' force concealed in the undergrowth. 'Blue's' reaction is to fan out, whereupon 'Orange' exercises a pincer movement—surrounding the enemy.*

US National Archives

▷ *Motorized transport came into its own in the Chaco War. Here, Bolivian troop trucks are carried to the Nanawa front on railway.*

US National Archives

▷ *One of Bolivia's Vickers Type B light tanks at Pirijayo, August 1933.*

◁ *The Ford Tri-Motor. Although well supplied with such planes, Bolivia under-estimated the value of air reconnaissance.*

1st Corps to more easily defended positions in front of the new HQ. He stressed the importance to 'national morale' of defending this emotive spot—the symbol of Bolivia's military presence in the Chaco. Penaranda had no choice but to give in to the demands of the officer commanding the bulk of his forces. From then on, Toro acted largely as his fancy took him—regardless of the wishes of his superior who continued to carry the can for Bolivia's frequent setbacks.

The Paraguayan 3rd Corps had by now reached Ballivian. In spite of the disparity in numbers between the 9,000 besieging force and the 16,000 defenders another stalemate developed.

Because further advances in this sector were temporarily impossible, Estigarribia attempted an envelopment of the Bolivian left flank. This maneuver began with a successful attack by the reinforced Paraguayan 6th Division. They smashed through weak resistance in the region of Picuiba—pushing on almost unopposed to the foothills of the Andes.

Unfortunately the Paraguayans lacked the resources to back up this daring maneuver and the 6th Division was ordered to withdraw slowly—holding the attention of the enemy, who poured reinforcements into this sector at the expense of Ballivian.

Toro had temporarily relinquished command at Ballivian to lead a strong detachment in the north. When reinforced, this turned into a Cavalry Corps of two divisions, with an infantry division of 3,000 men from the 2nd Corps, added for good measure. On 5 September this force caught up with the retreating Paraguayans and encircled them. The latter managed to escape three days later at the cost of abandoning their artillery and most of their heavy equipment.

Estigarribia's patient strategy paid off on 15 November when part of the force detached to cut off the retreating 6th Division was surrounded and itself cut off and forced to surrender by the three-division Paraguayan 1st Corps at Canada El Carmen. Although 2,500 Bolivians fought their way out, as many died in a futile attempt to escape the Paraguayan encirclement. The survivors of the two-division force—4,000 men—were forced to give themselves up when they ran out of water.

This action exposed the northern flank of the Bolivian 1st Corps which now withdrew, without further opposition, from Toro. Ballivian was abandoned and the Paraguayans occupied it on 17 November.

The friction between the Bolivian political and military leadership now came to a head. President Salamanca—blaming the succession of disasters on the incompetence of

POTEZ 25 (PARAGUAY)

Engine *one Lorraine 450hp SGA 8-cylinder Vee type.*
Span *46ft 4¾in*
Length *29ft 10⅛in*
Height *12ft 0½in*
Weight *4,317lb*
Top speed *137mph at sea level.* **Service ceiling** *23,622ft.*
Range *410 miles.*

Peter Sarson/Tony Bryan

his generals—naively journeyed to the Chaco to inform them in person of his decision to dismiss them *en masse*. A *coup d'etat* at Villa Montes replaced Salamanca with the Vice President, Tejada Sorzano. It resulted in Salamanca's exile to his native town of Cochabamba. Several months later he died.

Meanwhile, in the NE, Toro's unscathed Cavalry Corps sought to make up for the catastrophe of El Carmen. It tried to take the Paraguayan main force in the rear by a flanking movement past the still retreating 2nd Corps.

Forseeing this, Estigarribia sent the small 1,800-man 8th Division to cut through seemingly impossible country and capture Toro's only water source—the wells at Yrendague—from the rear. By 7 December this was accomplished, whereupon the 2nd Corps made an unexpected stand, turning to face their pursuers—to the consternation of the latter. Too late, the Bolivians realized the loss of the vital wells, detaching the 7th Infantry Division to try to retake them, but they failed. Meanwhile, the cavalry divisions came under heavy attack and were forced to retreat. Days later 4,000 Bolivians—crazed with thirst—surrendered. The escape of a further 7,000 men—many of whom were later to die of thirst before reaching their own lines—was only made possible by a timely rainstorm.

The Bolivian Command struggled desperately to establish a new defensive line in the Andean foothills to protect the territorial integrity of Bolivia. Then a daring raid by the Paraguayan 3rd Corps penetrated deep into enemy territory —capturing 3,000 prisoners and much material and bringing the important Bolivian oil-fields at Santa Cruz under threat.

By now the main Paraguayan army had reached Villa Montes and laid siege. This was the Bolivians' last important stronghold in the Chaco. It was tenaciously defended by Colonel Bilbao Rioja—their most competent field commander. He had previously been denied important command due to political jealousy.

After a month of futile, costly frontal attacks, reminiscent of those by Kundt at Nanawa two years earlier, Estigarribia's 1st Corps settled down to a static war of attrition at Villa Montes.

Paraguay's 2nd Corps had now pushed once more into the Andean foothills. They threatened the important city of Santa Cruz and provoked an ill-prepared counter-offensive of only limited success by the resurrected Cavalry Corps and 2nd Army Corps.

In mid-April, sorties by the defenders of Villa Montes caused the Paraguayans to pull back a little. But no real material advantage was gained and considerable losses were suffered.

Pressure on the Paraguayan 2nd Corps now was such that it was forced to retreat speedily. To relieve this pressure, Estigarribia personally led a raid by his 6th Division across the mountains of Mandeyapecua. He then intended to link with his 3rd Division to outflank the Bolivian 2nd Army Corps from behind.

This maneuver enjoyed only limited success and the Paraguayan leader's own men came under pressure from an enemy force detached from farther north. By daring tactics he managed to infiltrate and disperse them.

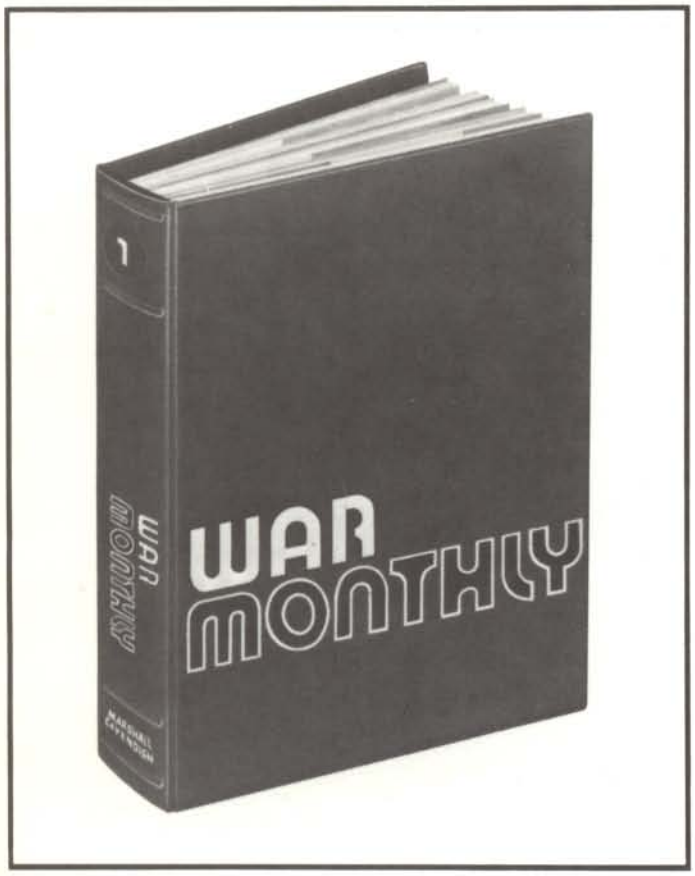
Total stalemate now developed. The Paraguayans lacked the resources to break the Andean defenses and pursue the war to victory. For their part, the Bolivians, despite their greater economic and human resources, had proven amply that they were no match for the Paraguayans in the Chaco lowlands.

Both sides were now amenable to renewed peace initiatives on the part of the South American Neutral bloc—now joined by the US. A Peace Protocol was signed on 12 June and on 14 June 1935 the Chaco War was effectively at an end.

Treaty negotiations dragged on until 21 July 1938. This was longer than the war itself. The agreement finally reached awarded 80% of the disputed territory to Paraguay—giving her the boundaries she enjoys today.

Although the fighting at Nanawa, Ballivian and Villa Montes resembled World War I—static warfare at its worst—much of the mobile phase of operations gave a foretaste of what was to come in South East Asia during World War II and subsequently in Malaya and Vietnam.

Adrian J. English



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